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DOCTOR OF PHILOSOPHY

An Exploration of a Graphical User Interface (GUI) to Facilitate the Creation of Internet Interventions

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Claire Jones

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**An Exploration of a Graphical User Interface (GUI)
to Facilitate the Creation of Internet Interventions**

Claire Jones

Doctor of Philosophy

University of Dundee

June 2014

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“Those we love don’t go away, they walk beside us every day, unseen, unheard, but always near, still loved, still missed each passing year.”

Declaration by the candidate

I hereby declare that the work described in this thesis is my own work; that I am the author of this thesis; that it has not previously been put forward in submission for any other higher degree or qualification; and that I have consulted the references listed in the table of references herein.

Signed

Claire Jones

June 2014

Declaration by the supervisors

We certify that Claire Jones has satisfied all the terms and conditions of the regulations made under Ordinances 12 and 39, and has completed the required nine terms of research to qualify in submitting this thesis in application for the degree of Doctor of Philosophy.

Signed

Prof Ian W Ricketts

June 2014

Prof Shaun Treweek

June 2014

Summary

An exploration of a Graphical User Interface to facilitate the creation of Internet Interventions

Unsurprisingly the National Health Service (NHS) has harnessed the prolific growth in Internet access to alleviate the increasing burden incurred due to rising healthcare costs. Healthcare interventions focus on the promotion of good behaviours; prevention of bad behaviours; provision of support for shared decision making; increasing knowledge and improving monitoring.

Healthcare researchers typically rely on professional software developers in the creation of Internet interventions. Although varying in nomenclature Internet interventions typically consist of the same underlying components, such as navigation, logic and response capture. The LifeGuide Authoring Tool provides a potential solution to reduce this reliance of researchers on software developers in the creation of interventions. However the logic creation command line interface provided by LifeGuide is identified as a potential barrier for adoption, by non-programmers, due to their lack of experience with the strict programming style syntax it requires.

Through the adoption of user-centred design techniques; early and continuous user involvement; rapid prototyping and interface design principles, a Graphical User Interface (GUI) was developed, with the potential to lower this barrier for researchers with no previous programming experience. A jigsaw metaphor was

adopted in the design of the interface, utilising templates and pre-populated fields, with the aim of reducing errors and lowering the cognitive load experienced by users.

A task-based evaluation compared the existing LifeGuide interface, with the new GUI, in the creation of commonly used logic. Higher results were reported over the five main usability measures: effectiveness; engagement; efficiency; ease of learning and error tolerability in favour of the GUI, in the creation of intervention logic.

Continuing requests to the author to develop healthcare Internet Interventions supports the research, that there is still a heavy reliance of researchers on software developers. A further application for this approach was identified in the development of a tool to support healthcare researchers in the creation of mobile phone messaging interventions.

Chapter 1 Introduction

1.1. Introduction

The National Health Service (NHS) is increasingly burdened by rising healthcare costs and limited resources. Major contributors to this are the growing ageing population, higher survival rates of people living with long term conditions and the care for diseases linked to unhealthy lifestyles.

By 2032 it is expected that the population aged 65 years and over will increase by almost half, in the same period those aged 90 and over are expected to increase by 149%. Each year, approximately £5 billion of public funding in Scotland is spent on health and social care for those over 65 years (Scottish Public Health Network, 2012). There is a known correlation between age and long term conditions, Audit Scotland (2007) predict that by the age of 65, nearly two-thirds of people will have developed at least one long term condition, with 27% of people aged 75-84 suffering from two or more such illnesses.

Long term or chronic conditions are health problems which impact on a person's life, which may require on-going care and support. Conditions such as high blood pressure, depression and arthritis are examples of long term conditions which can be controlled by medication, or other therapies but cannot be cured. Over 15 million people in the UK are living with long term conditions; this figure is set to increase over the next 10 years, with people suffering from multiple conditions. Long term conditions are causing a significant increasing burden to the economy due to changes

in demographics; the aging population and as a result of medical advancements people suffering from long term illnesses now have an increased survival rate. Eighty percent of all GP consultations and over 60% of hospital bed days can be attributed to treatment of long term conditions (Scottish Government, 2012) often which require longer hospitalisation periods. In addition to the support and costs associated with treatment of long term conditions, people living with such conditions are also more likely to experience psychological problems.

A further contributor to the increasing NHS encumbrance relates to the care of diseases associated with unhealthy lifestyle choices. The care of smoking-related illness costs the NHS in Scotland approximately £400 million on an annual basis and is accountable for around 33, 500 hospital admissions. Alcohol related issues not only result in a cost to the NHS, but also impact Social Work Services and the Criminal Justice System. In 2011 the combined costs to these services was reported as £1.1 billion.

New approaches are necessary to support the NHS in caring for the UK population, which not only focus on lowering the deficit incurred by the aging population, long term conditions and disease prevention but also support the overall care package provided to the whole population. Healthcare interventions provide one approach to support NHS sustainability. Healthcare interventions do not serve as a replacement to standard face-to-face care but in combination, provide a complementary synergistic healthcare package. When evaluating effectiveness of interventions consideration must be given to the true comparability of the platforms (face-to-face,

paper or web-based alternatives) and to the varying potential user groups (Kamel Boulos *et al*, 2009).

Healthcare interventions can be defined as “*Any type of treatment, preventive care, or test that a person could take or undergo to improve health or to help with a particular problem. Healthcare interventions include drugs (either prescription drugs or drugs that can be bought without a prescription), foods, supplements (such as vitamins), vaccinations, screening tests (to rule out a certain disease), exercises (to improve fitness), hospital treatment, and certain kinds of care (such as physical therapy).*” (Agency for Health Research and Quality, 2014).

For the purpose of the research discussed in this thesis a healthcare intervention is defined as a non-drug intervention, for either or both healthcare professionals and patients used to promote good behaviours; prevent bad behaviours; provide support for shared responsibility in treatment decision making and to increase knowledge and improve monitoring. Technology enhanced healthcare interventions provide the opportunity for patient focused healthcare by allowing for anywhere, anytime access to resources. A Web-based intervention is defined as:

“... *a primarily self-guided intervention programme that is executed by means of a prescriptive outline programme operated through a website and used by consumers seeking health- and mental-health related assistance. The intervention programme itself attempts to create positive change and or improve/enhance knowledge, awareness and understanding via the provision of sound health-related material and use of interactive Web-based components.*” (Barak *et al*, 2009)

The development of software based healthcare interventions can be a challenging process, due to the involvement of multiple stakeholders from varying disciplines, all communicating their individual requirements to the software development team. Domain experts may find it difficult to convey the complex health conditions and underlying rules required in the intervention. A typical patient focused intervention will involve: researchers with the hypothesis they are seeking to investigate; healthcare professionals providing the factual information; psychologists tailoring interventions which focus on data collection and behaviour change techniques; statisticians concentrating on the intervention output and most importantly patient representatives. One solution to combatting the challenges encountered by the involvement of multiple user groups is through the adoption of user-centred design principles.

The primary research theme discussed throughout this thesis examines how user-centred design techniques and empowering users as design partners can not only create usable healthcare interventions. This theme is further extended in the design of an interface to reduce the reliance of healthcare researchers on professional software developers, in the creation of software based interventions. Rapid prototyping with continuous user involvement are crucial to the success of usable software solutions, with usability evaluations serving to confirm the solution fits the users' needs, frequent evaluations were central to the research presented.

The research presented in this thesis was conducted over a nine-year period in collaboration with healthcare researchers, statisticians and psychologists from the

Universities of Dundee, Bristol, Southampton and Aberdeen as well as patients and healthcare professionals from both NHS Scotland and England.

The main focus of the research was to reduce the reliance of healthcare researchers on professional software developers in the development of web-based interventions.

This approach was found to be particularly pertinent because:

1. Bespoke software development is expensive.
2. Healthcare researchers heavily rely on professional software developers to further healthcare research.
3. There is a distinct lack of a usable tool which healthcare researchers can utilise in the creation of Internet Interventions.
4. Independently developed software becomes redundant on project completion; lack of reusability.
5. Basic piloting of ideas still requires significant funding.
6. Healthcare grant funding bodies are hesitant to fund high software development costs.
7. Additional software requirements are difficult to fund if outwith the funded development period.
8. The Medical Research Council (MRC) Framework (2008) suggests the development of complex interventions should adopt an iterative development, modelling and evaluation methodology.
9. Experience in developing interventions highlighted commonalities in intervention functionality requirements, which suggest the possibility of a tailored software solution.

The research culminated in the creation of a functional software prototype, developed with potential system users as design partners, which focused on user-centred design techniques. The tool facilitated user engagement in both evaluation and workshop settings, through the demonstration of familiar potential applications applied to healthcare research. The prototype emphasised to potential users its ease of use and success in lowering barriers for non-programmers in the development of Internet Interventions. The tool was used to measure the successfulness of the research discussed in a direct comparison, task-based experiment, where usability metrics were assessed for both the prototype in combination with an existing software tool, and the existing software tool independently in its current ‘*off the shelf*’ availability.

1.2. Research focus

The main aim of the research was to explore the hypothesis that:

The provision of a usable software tool designed adopting user-centred design techniques can reduce the reliance of healthcare researchers on professional software developers in the creation of Internet Interventions.

In seeking to address this hypothesis particular attention was focused on:

1. Current processes in the development of Internet Interventions by:

- *Identification of the different types of healthcare interventions*
- *Investigation into how these interventions are currently developed*

- *Development of software based interventions for multiple disparate healthcare conditions*
- *Understanding the functional requirements of a web-based healthcare intervention*

2. How to design an intervention creation tool adopting user-centred design techniques by:

- *Analysis of the user group profile requirements*
- *Early and continuous user involvement*
- *Use of iterative design lifecycles*
- *Implementing user interface design principles*

3. Does adopting a user-centred design approach produce an effective; efficient; engaging; error tolerant and easy to learn tool which will in turn bridge the current gap for healthcare researchers in the creation of Internet Interventions by:

- *Evaluation of the tool with potential users focusing on usability metrics*

1.3. Outline of thesis

This thesis is divided into 8 chapters. Chapter 2 provides the background to healthcare interventions; their varying formats; discusses the benefits and pitfalls of web-based delivery and highlights the importance of user-centred design in the development of interventions.

Through the use of case studies Chapter 3 identifies the commonalities in requirements and design of three healthcare interventions with a focus on obstetric care, dentistry and depression. Attention is drawn to the reliance of healthcare researchers on professional software developers and the deficiency of a usable Internet Intervention creation tool.

Chapter 4 describes the development of an initial pilot software tool designed to facilitate the creation of Internet Interventions by researchers. User-centred design techniques; rapid prototyping and early and continuous user involvement were again adopted where the development was based on a '*real world*' case study.

While in the process of seeking funding to further the tool discussed in Chapter 4 a potential alternative package, LifeGuide was discovered. Chapter 5 considers the functionality provided by this solution and suggests a potential flaw in the underpinning concepts when focusing on the intended user group.

Chapter 6 follows the development of LogicBlocks, a Graphical User Interface (GUI) which provides an alternative interface to LifeGuide, designed to reduce the programming skills required thus allowing researchers to fully benefit from LifeGuide and therefore increasing its potential to reach a larger target user group.

A task-based summative usability evaluation was conducted with potential users comparing the standard LifeGuide software with LifeGuide in combination with LogicBlocks. The evaluation design and experimental findings are presented in Chapter 7.

Chapter 8 concludes the thesis by reviewing the research; the result presented and introduces recommendations for possible areas of expansion in the development of usable software tools to support healthcare research.

Chapter 2 Background

2.1. Introduction

This chapter considers the potential benefits and drawbacks of web-based intervention delivery, paying particular attention to cost; accessibility; convenience; anonymity; engagement and interactivity. The chapter follows on by describing the varying contexts in which web-based healthcare interventions are employed and concludes by exploring the principles of user-centred design. Techniques for increasing usability are identified, metrics to measure usability are introduced and examples of these principles in use in the design of healthcare interventions are provided.

2.2. Web-Based Interventions

On the 22nd December 1982 Dr Jack Buchanan instigated a paradigm shift in public health interventions with a simple post to the USENET-based social-networking system. In this post Buchanan presented a passage from the Morbidity and Mortality Weekly Report describing a “frightening” new condition which had been a hot discussion topic within the newsgroup. This was the first time that AIDS information was shared on the Internet (Bennet, 2009).

Unsurprisingly nearly thirty years later, with the proliferation of the Internet, the potential for this delivery mechanism in the field of healthcare interventions has been widely recognised. Several meta-analytic systematic reviews have reported the use and effectiveness of the Internet in the delivery of healthcare interventions. Lewis

(1999) provided support for computer-based education for patients but highlighted the need for additional research due to the limited number of research studies. Sixty six articles were indexed in MEDLINE or CINAHL from 1971 to 1998 using the search criteria “computer”, “informatics” and “patient education”. The articles primarily focused on chronic conditions such as diabetes and asthma but also included disease prevention programs. A subset of 21 research based reports presented significant rather than descriptive findings.

Following on from this in 2004 Wantland *et al* also focused on chronic illnesses and reported a twelve-fold increase in the number of MEDLINE citations for “Web-based therapies”. During the period 1996 to 2003, there was an increase from 13 to 152 citations and an increase in the use of the term “Web-based Interventions”. In this review 1518 citations were identified from MEDLINE, CINAHL, EMBASE, PSYCHInfo, ERIC and the Cochrane Library, which compared behaviour change outcomes of Web versus non-Web-based interventions. Only twenty of the articles passed the inclusion criteria. Wantland concluded that there is substantial evidence that the use of Web-based interventions can improve knowledge and/or behaviour change outcome variables. Portnoy *et al* (2008) undertook a similar meta-analysis focusing on the period 1988 to 2007 which also provided confirmation of improved behavioural health outcomes with the adoption of Web-based interventions at initial post intervention assessment. Portnoy concluded by suggesting that further evaluation is required to determine efficiency in the longer term, an important factor in support of chronic conditions. Seventy-five randomised controlled trials were identified which included 35, 685 participants and 82 separate interventions. The

behaviour outcomes measured were knowledge, attitudes, intentions and also health behaviour outcomes related to nutrition, tobacco use and substance abuse.

2.3. Effectiveness of Web-based Interventions

Murray (2012) proposed that in addition to measuring knowledge and understanding, that supplementary outcomes as discussed in the conceptual framework of self-management developed by Corbin and Strauss (1998) be included. In the area of web-based interventions relevant outcome measures include cognitive, behavioural and emotional outcomes (Murray, 2012). Cognitive outcomes include improvements in knowledge or understanding, successfully demonstrated in a decision aid in the field of obstetrics, with the author's involvement, led by Montgomery (2007). Behaviour change measures include smoking cessation and diet. Again, the author in collaboration with Treweek *et al* (2011) described the application of a behaviour change intervention to lower GP prescribing of antibiotics. Montgomery *et al* (2007) also reported emotional outcomes in the form of lowering anxiety; other topical emotions include anger, guilt and depression. Web-based interventions have been shown to be effective in improving all three outcome areas - cognitive outcomes (Cook *et al*, 2011), behavioural outcomes (Portnoy *et al*, 2008, Yardley *et al*, 2010) and emotional outcomes (Kaltenthaler *et al*, 2006).

With an increasingly ageing population and therefore the number of people living with long term conditions, any improvement in these outcomes, however small, can have a significant impact on the whole population. The requirement of web-based interventions is not to replace face-to-face treatments but to demonstrate comparable beneficial results (Ritterband *et al*, 2003).

2.4. Web-Based Interventions: Benefits and Pitfalls

As the Internet has reached ubiquitous levels, the volume of web-based interventions has also risen with good evidence of effectiveness in the area of healthcare. The benefits and pitfalls of web-based delivery have also been widely documented (Griffiths *et al*, 2006, Bell and Kahn, 1996, Ritterband *et al*, 2006, 2012, Royal Society, 2006, Portnoy *et al*, 2006, Powell *et al*, 2013). The reasons cited for using the Internet to deliver health interventions include low cost; instant accessibility; the potential for anonymity; higher user engagement and the ease of data capture.

2.4.1. Cost

One of the most commonly cited reasons for choosing to adopt a web-based approach in the delivery of healthcare interventions relates to reducing health service and delivery costs (Griffiths *et al*, 2006). The rationale behind this is that it is relatively inexpensive to deliver an intervention over the Internet compared with the equivalent cost of a healthcare professional's time. Internet interventions have the potential to reach a large number of people with marginal increases in cost for each additional user. Manual data entry and consumable costs such as printing and postage are removed through Internet access. Bell and Kahn (1996) evaluated the use of the Internet in the delivery of the Medical Outcomes SF-36 form which previously had limited adoption due to expensive administration and analysis costs. Bell and Kahn found the use of web technology to be capable of dramatically lowering the cost of performing both trials and routine monitoring. However the actual costs associated with developing the online form are not reported in the trial findings.

The costs incurred when creating Internet interventions are rarely reported but include software development; the health domain expertise to provide content and evaluate feedback; the infrastructure to deliver the intervention; on-going maintenance and updates. These so called “sunk” costs are commonly excluded from cost-effectiveness analyses because they are thought to be one-off costs, which will not be repeated once an initial system is in place (Tate *et al*, 2009). Tate reviewed cost-effectiveness studies published in PubMed from 1995 to 2008 using terms such as “Internet”, “online”, “cost-effectiveness” and “return on investment” which identified 420 published papers. However only 8 met the main inclusion criteria of reporting cost measures associated with the intervention delivery. All 8 articles reported cost benefits in favour of Internet interventions however the results were either inconclusive or subject to criticism when extended to real-world situations.

An economic evaluation of the DiAMOND Study which focused on mode of delivery among women with a previous caesarean section (Hollinghurst *et al*, 2010) excluded development costs for developing two interventions “*to reflect the on-going (negligible) costs of their use*”. In actuality the software created in this study was developed over a period of 4 months. Multiple stakeholders were involved including obstetric specialists, software developers, nurses and patients. Technology enhanced approaches are susceptible to the same updates as traditional methods, with updates required when new guidelines are adopted or appearance updates. However web-based approach is under considerably more pressure than traditional methods given the ever changing technology trends and users’ expectations, resulting in on-

going development costs rather than the one off-cost typically reported. Atkinson *et al* (2009) supported this need for dynamic website content, where study participants voiced their disinterest with static websites favouring regular updates both to content and features. Tate *et al* (2009) identified the need for improved dissemination of the detailed costs of developing and implementing Internet interventions, to better inform decisions on the cost-effectiveness use of healthcare resources. Specifically the cost of developing and disseminating the intervention, the outcome variables used to measure cost effectiveness and appropriate comparison platforms.

2.4.2. Accessibility

The most appealing and beneficial reason cited for embracing the Internet in the delivery of healthcare interventions is the ability to reach the mass population easily and comprehensively. The Internet potentially provides a self-paced, anywhere, anytime, inclusive platform to health resources for patients. Particularly beneficial to those who live in remote locations and who may therefore experience difficulties accessing healthcare services. The digital divide is decreasing however, and the ‘content gap’ also needs to be considered, “*when people are able to get online, they may not find information designed for them and their needs, especially harder to reach populations.*” (Atkinson *et al*, 2009).

Previously it was thought that web-based interventions may have exacerbated health inequalities by excluding those who did not have access to the Internet. However access to the Internet has increased with 43.6 million adults (86%) in the UK having used the Internet in 2013, including 36 million (73%) adults accessing the technology every day. This is an increase of over 20 million since 2006. 7.1% of

the adult population have never used the Internet but this gap is decreasing. The number of adults who had never accessed the Internet fell by 10% during 2012-2013. Technological advancements have led to flexible access to the Internet through a variety of media including computers, laptops, tablets, mobile phones and televisions. 83% of households in the UK have Internet access (Figure 2.1); the number of mobile phones users accessing the Internet doubled between 2010 and 2013 to 53% (Office for National Statistics, 2013).

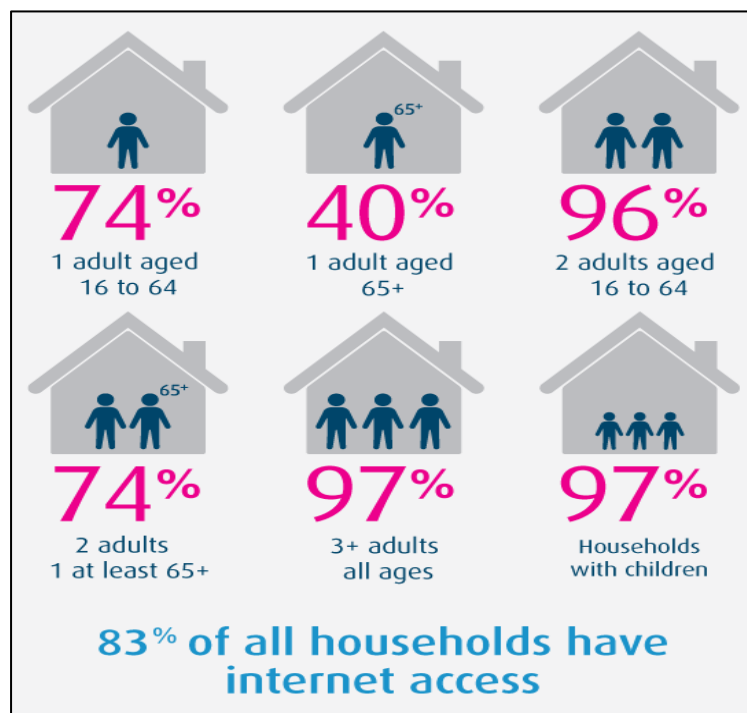


Figure 2.1 2013 Households with access to the Internet (Office for National Statistics Q2, 2013)

Focusing on the UK demographic, in households who have access to the Internet gender is relatively equally represented (Figure 2.2). However there is a difference of 34% between the populations of over and under 65's who have access to the Internet. Age is a major factor in the demographics of individuals who have used the Internet (Figure 2.2). 99% of adults aged 16 to 24 have used the Internet compared

with only 33% of adults aged 75 and over. The 3.2 million non-users aged 75 and over account for almost half of the population who have never used the Internet.

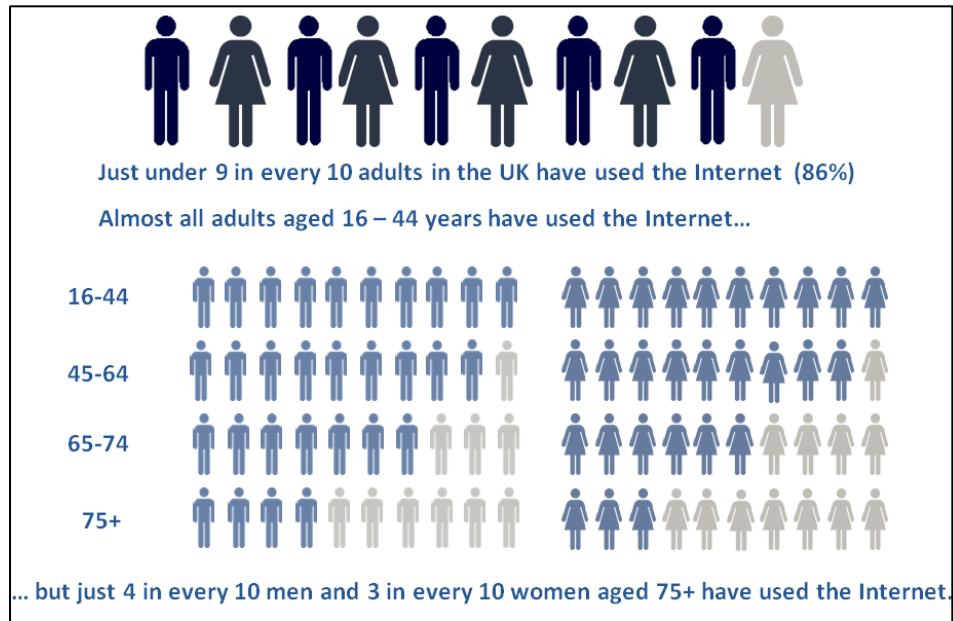


Figure 2.2 Internet Users by Sex and Age Group (Office for National Statistics Q2, 2013)

Although the number of users accessing the Internet is continually increasing, depending on the topic and potential target user group, the accessibility of the Internet as the most appropriate delivery platform needs to be carefully considered.

2.4.3. Platform Independence

“The Web is platform independent because its functionality does not depend on the specific type of computer hardware or software used by either the client or the server” (Bell and Kahn, 1996). In essence this statement is correct; however the design and layout of an Internet intervention may be visually altered depending on the browser and operating system used. Compatibility testing is required before making this assumption of independence. The potential viewing platform and environment should also be considered in the design of Internet interventions.

Consider an intervention designed to be used in a hospital setting, where a connection to the Internet may be absent and users may only have access via mobile devices or only via older systems.

2.4.4. Technology Enhancements

The Internet provides a resource for storing virtually unlimited amounts of information and facilitates presentation of material in an accessible and comprehensible format (Murray *et al*, 2012). By providing usable navigation and embracing multimedia functionality, information can be divided into manageable pieces, which can be easily visualised using a variety of formats. Video, audio and graphics can support users, particularly with low literacy skills, in understanding complex information such as in communicating health risks. Terminology such as “likely” or “rare” or numerical information such as ratios are open to interpretation, thus information must be presented clearly to avoid cognitive overload (Edwards *et al*, 2002). Atkinson *et al* (2009) found study participants were visual learners; preferring graphical representation to text. Montgomery *et al* (2007) incorporated web-based enhancements into an information website, in the presentation of risk information, in the obstetrics by providing three alternative formats – one numerical and two pictorial (Figure 2.3).



Figure 2.3 Alternative Risk Presentations

Study participants found the different formats useful, with preferences expressed for each format:

“I find that’s very clear... the number format. The figure format, that wouldn’t be the way I would choose to view it...and probably not the pie chart format either.”

“I really like that; I really like that pictorial representation of all the people. That really makes it very clear to me.”

That’s quite good how they’ve done that [figure format], it sort of grabs your attention more and it’s a lot easier to understand”

“I liked the pie charts. If you see 2 in a 100 you think ooh, but on the grand scale of a pie chart, you think, oh yeah it is small”

2.4.5. Anonymity

At least 50% of patients’ health problems are caused by preventable behavioural risk factors, including human immunodeficiency virus (HIV); infection; alcohol and drug

misuse; tobacco use and domestic violence (Gerbert *et al*, 1999). The behaviours associated with these health risk factors are highly stigmatised and patients may feel uncomfortable discussing these topics openly and honestly with their healthcare professional.

Traditional methods of assessing patient risks have used written questionnaires or face-to-face interviews. Web-based technologies provide an alternative platform offering anonymity, thereby increasing the sense of privacy and reducing stigma. Gerbert *et al* (1999) carried out a randomised controlled trial with 1985 participants which evaluated participants' willingness to provide sensitive responses knowing that their responses would be shared with their healthcare professional. The aim was to assess whether the method of response delivery had any effect on openness. The methods of delivery discussed were traditional written questionnaires and face-to-face interview versus technology enhanced audio, video or computer-based questionnaire. The health focus was on HIV risk factors; alcohol; drug use; domestic violence; tobacco use; oral health and seat belt use. The findings suggest that patients were willing to disclose health risks to a researcher knowing their responses could be shared with their physician. The technology enhanced delivery methods (audio, computer and video) produced between 4-8% greater risk disclosure in the areas of HIV, alcohol and tobacco compared with traditional methods.

Locke *et al* (1990) also investigated the use of computer-based interviewing in the area of HIV transmission focusing on screening for blood donation. Despite improvements in HIV testing there is still a time delay between exposure to HIV and developing the HIV antibodies which produce a positive test result. Donation by

infected donors can potentially be reduced through improved donor screening and questionnaires related to high risk behaviours. Locke developed a computer-based interview for screening which they evaluated with 64 blood donors between June and July 1990. When asked to compare computer-based interviewing with human interviewers 50% of participants said they would be more honest with the computer interview compared to 9.3% who would be more honest with a human interviewer.

2.4.6. Engagement

Creating and maintaining interest is extremely important when designing healthcare interventions. It is imperative that interventions encourage and support long term exposure or multiple accesses particularly pertinent when focusing on chronic conditions. According to Ritterband *et al* (2003) there are three main components, which when implemented, can result in a more immersive and engaging environment:

- Multimedia - audio, video and image components via Internet delivery
- Interactivity
- Personalisation

Enable a more individualised and tailored experience. Tailoring interventions is also supported by Fisher and Fisher (1992), Ryan and Lauver (2002) and Kaufmann (2007) who report enhanced behavioural change, increased efficacy and user satisfaction as well as a more engaging experience.

In examining the effectiveness of a web-based smoking cessation intervention Richardson *et al* (2013) highlighted the efficacy of sustained levels of interaction on abstinence prediction, emphasising the importance of engagement through

interactive features. Results presented build on existing evidence suggesting the value in finding ways to increase repeat visits, engagement and retention of users. Richardson *et al* found the use of both a community network and separation exercises most significantly predicted abstinence, however a quit planning feature had a negative association with quit attempts, further supporting the benefit of pilot testing of interventions with potential users.

Tailoring involves presenting users with personalised messages and only relevant information based on their individual responses to previous questions or selections. Tailored versus standard Internet interventions was compared by Hageman *et al* (2005) in a randomised controlled trial in the area of promotion of physical activity in older women where women either received three standard or three tailored newsletters. The reported findings support the Internet as a delivery mechanism for behaviour change interventions, suggesting that extended periods of interaction may increase effectiveness outcomes however the comparison of tailored versus standard messages effectiveness was found to be inconclusive.

2.4.7. Data Capture

Direct data capture mechanisms such as web-based questionnaires offer immediate data analysis, are less error prone due to the removal of duplicate data entry and provide enhanced logging functionality compared to traditional paper-based collection methods (Weber *et al*, 2005). Web-based delivery provides the opportunity to record quantity, frequency, duration and time of access, flow between pages and commonly used features which cannot be recorded with paper-based or CD-ROM-based equivalents. This logging information can be extremely useful

when piloting interventions, drawing attention to the areas most visited or questions which may be causing difficulty in answering. However, caution must be taken in making assumptions about time lapse data as the user may have simply ceased interacting with the intervention.

2.5. Developing a Web-based Intervention

The most significant challenge in adopting a web-based approach in the delivery of healthcare interventions lies in the development of the intervention. *“Developing Internet interventions is an arduous, sometimes tedious, and always time-intensive process. It necessitates an interdisciplinary approach, requiring a team of diverse professionals...”* (Ritterband *et al*, 2003). Tools currently exist for researchers which can be applied to creating websites or questionnaires such as the Bristol Online Survey or WordPress, however, these applications are limited in the functionality they provide for intervention delivery, and thus a professional development team is often required. A typical interdisciplinary team consists of potential users; researchers; software engineers; graphic designers; healthcare professionals, psychologists and statisticians. This multidisciplinary approach can be expensive and limiting for early career researchers (Yang *et al*, 2009) and ultimately places a heavy reliance of researchers on professional software developers. The efficacy of web-based interventions in the field of healthcare has been extensively documented and reviewed; however there is limited explanation as to who developed these interventions and how they were created. The International Society for Research on Internet Interventions (ISRII) was formed in 2004 to urge collaboration regarding development, testing and dissemination of web-based interventions (Ritterband *et al*, 2006).

2.6. Types of Internet Interventions

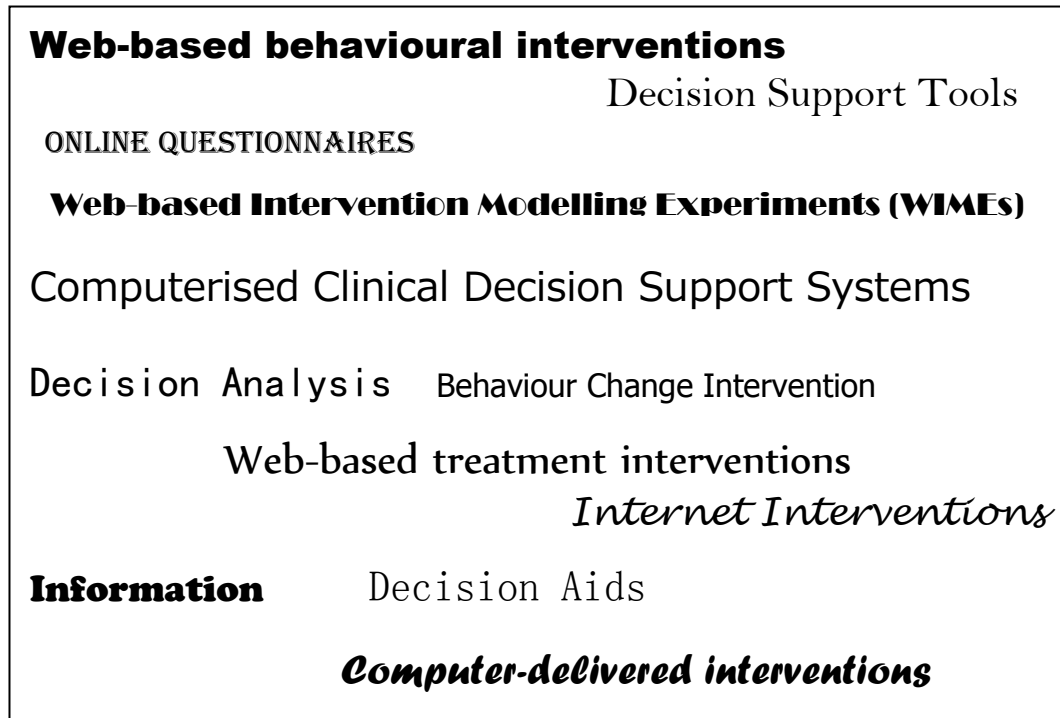


Figure 2.4 Nomenclature of terms representing Internet Interventions

The literature uses varying terminology in the designation of health related information and interactions delivered over the Internet (Figure 2.4). The most regularly used expressions include:

2.6.1. Decision Analysis/Aids

Decision analysis facilitates both shared decision making between patients and their healthcare provider and can support clinical decision making through the recommendation of tailored care based on a patient's characteristics. Decision analysis can lead healthcare provision away from a paternalistic (clinician decides) approach to a partnership (shared decision) or delegation model (patient decides) (Elwyn *et al*, 2001). Implementing Von Neumann and Morgans's (1947) model

for human decision making in the healthcare setting and built on the foundations of a decision tree, the likely probability of a health outcome such as the risk of stroke combined with the patient's dislike for taking medication are combined to produce an overall rating. This preference outcome can then be used as a basis for discussion between the healthcare professional and the patient regarding the most appropriate treatment plan. The Internet or desktop software provides a platform to deliver such decision aids.

Computerised clinical decision support systems (CCDSSs) may be one solution to alleviating the burden of chronic conditions on practitioners (Roshanov *et al*, 2011). Chronic conditions require complex treatment plans which can often be further complicated by multiple conditions. Decision analysis can be used to provide the most appropriate treatments options based on the patients individual attributes. Roshanov *et al* conducted a systematic review of CCDSSs referenced in MEDLINE, EMBASE, Ovid's Evidence-Based Medicine Reviews, and Inspec, up to January 2010. The aim was to compare CCDSSs with usual care or non-CCDSS controls reporting the improvements relating to disease management processes on patient outcomes. Fifty-five articles were identified which passed the inclusion criteria focusing on the most common chronic conditions including diabetes, hypertension and asthma. The results suggest that just over half of the CCDSSs presented improved care processes with 31% of trials demonstrating benefits in patient outcome particularly in the field of diabetes. Hypertension, asthma and COPD interventions reported the least effective results.

Montgomery *et al* (2000) also reported similar findings with a clinical decision support system in the field of hypertension. In a three-arm cluster randomised

controlled trial they compared CCDSS plus cardiovascular risk chart, cardiovascular risk chart alone and usual care. The results showed no perceived benefit relating to lowering cardiovascular risk with patients who received either intervention compared to usual care emphasising the need for further investigation in this area. Conversely the same lead authors reported the successful implementation of a computerised decision aid in the field of obstetrics which reduced decisional conflict, increased knowledge, lowered anxiety and led to an associated increase in women achieving a vaginal birth compared with usual care (Montgomery *et al*, 2007).

2.6.2. Interactive Health Communication Applications

Murray *et al* (2005) defined an Interactive Health Communication Applications (IHCAs) as “.. *computer-based, usually web-based, information packages for patients that combine health information with at least one of social support, decision support, or behaviour change support*”.

Traditionally IHCAs were developed for non-web-based delivery such as CD-ROM deployment but have since evolved to a web-based approach. Benefits of IHCAs include the simplicity of transmitting information; supporting shared decision making; promoting good health behaviours and the potential to lighten the burden on the health service. In contrast, concerns have been raised relating to inaccurate or misleading information content and security/confidentiality of personal health information.

In a systematic review of IHCAs published from 1990 – 2003, Murray *et al* (2005) identified 24 studies which involved a total of 3739 participants from The Cochrane

Library, MEDLINE, EMABASE, PsyINFO, grey literature and national trial registers. The health topics covered the most prominent chronic conditions including asthma, cancer and diabetes. The result suggested that interactive health communication applications lead to increased knowledge, social support, clinical outcomes and improved health behaviours. There was also evidence to suggest that IHCA's are likely to have a positive impact on self-efficacy whilst economic and emotional effects could not be reported due to a lack of data.

2.6.3. Behaviour Change Interventions

“Behavioural interventions are used by social scientists to effect change in a person’s behaviour” (Osmond et al, 2009).

An example of a typical behaviour change intervention is the promotion of smoking cessation by providing tailored advice over an extended period. A successful intervention reports a change in the participant’s behaviour as a result of the advice provided. Traditionally behaviour change interventions have been delivered face-to-face which can be costly and resource intensive (Yardley et al, 2009). Kerr et al (2006) supports the use of the Internet as a delivery platform for behaviour change interventions in the provision of a stimulating and actively supportive environment. Effective behavioural interventions have adopted a variety of techniques in the support of behaviour change such as stress management and communication skills training spanning a number of different health fields such as physical activity, alcohol misuse and safe sex (Webb et al, 2010). A review of the ISI Web of Knowledge between 2000 and 2008 identified eighty-five studies which satisfied the inclusion criteria in the identification of which characteristics of web-based

interventions to promote health behavioural change. The results showed an increase in effectiveness on behaviour in interventions which employed additional participant communication, incorporated more than one behaviour change technique and focused on the theory of planned behaviour.

2.6.4. Complex Interventions

In 2000, the MRC published a Framework for the development and evaluation of randomised controlled trials (RCTs) of complex interventions to improve health. Since introduction this framework has been highly influential and widely cited relating to best practice in the development of healthcare interventions. Complex interventions “*comprise a number of separate elements which seem essential to the proper functioning of the intervention although the “active ingredient” of the intervention that is effective is difficult to specify*”. These elements include behaviours, parameters of behaviour, methods of organising and delivering those behaviours (MRC, 2000).

Subsequently the MRC published updated guidance (MRC, 2008) which replaced the previous five phase sequential which was similar to that of the evaluation steps adopted in a drug trial with an iterative four stage development-evaluation-implementation process model (Figure 2.5); allowing for flexibility.

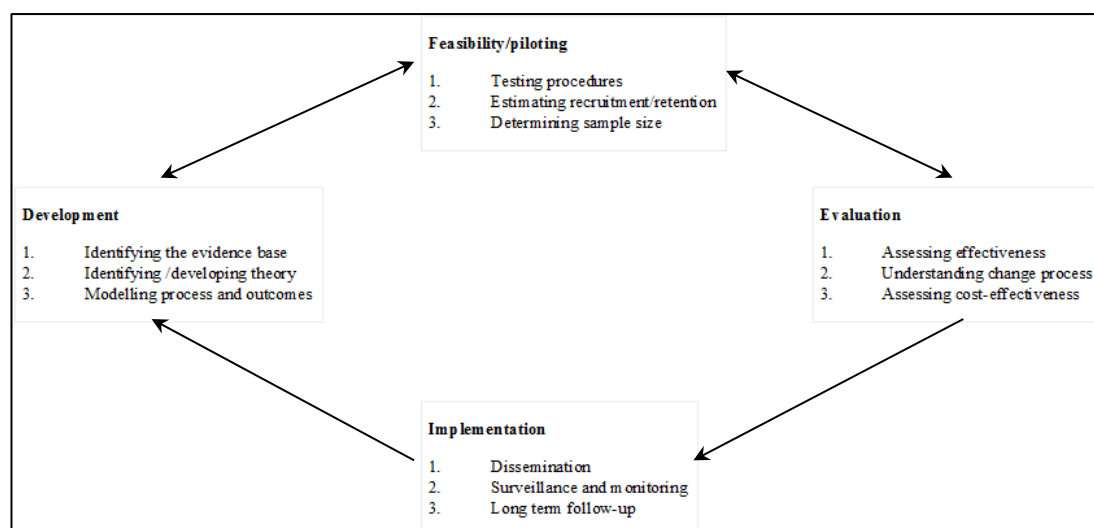


Figure 2.5 MRC Framework (2008)

The framework was designed to aid the considerable challenges faced with complex interventions (Campbell *et al*, 2007). When trials are reported often a full description of the processes and decisions made are not provided, making it difficult to determine why the trial achieved positive or negative results. The main question raised with either type of result is would the same outcome be found if the approach was adopted in a subsequent study, and which components would be beneficial for reuse. It can be difficult to establish which components of a trial have the greatest impact on the outcome; was the negative outcome simply due to an ineffective intervention suggesting that similar interventions would elicit the same outcome or was there a flaw in the trial design?

Initial stages of the framework emphasise preliminary modelling and testing prior to a full-scale trial. Although varying in rigor complex interventions are generally tested prior to rolling out a full-scale trial however this pre-trial testing is often not reported (Treweek and Sullivan, 2006). Eldridge *et al* (2005) support the importance of modelling as a precursor to trial design. Using pilot study data to model a trial focusing on the reduction of fall-related injuries in older people uncovered a

potential issue relating to reaching target users thus allowing for the trial design to be altered before rolling the intervention out in a full trial. The Internet offers the potential of a flexible platform to evaluate pre-trial interventions with access to a large user pool prior to commencing a full-trial.

2.6.5. Intervention Modelling Experiments

One approach to conducting the preliminary steps in the MRC framework and another type of healthcare intervention, similar to a behaviour change intervention, is known as an Intervention Modelling Experiment (IME), or more recently, Web-based Intervention Modelling Experiment (WIME). The objective of such experiments is to manipulate key elements of an intervention in a way that simulates the ‘real-world’ as closely as possible but where the measured outcome is a proxy for the behaviour measure of a full trial. Bonetti *et al* (2005) describe the reasons for implementing an IME, *“Using interim endpoints, which are easier and cheaper to measure than actual behaviour, means that an Intervention Modelling Experiment functions as a resource-efficient tool to enable intervention design modification, while providing a scientific rationale for intervention selections. An intervention should successfully change the experiment’s proxy outcome before being considered eligible for testing on actual behaviour in a definitive randomised controlled trial”*. Hrisos *et al* (2008) promote the use of IMEs in determining effectiveness of interventions and impact at service-level.

Using a paper-based IME Bonetti *et al* (2005) reverse engineered a ‘real-world’ randomised controlled trial focusing on lowering x-ray referral in the care of lower back pain. The intervention consisted of audit, feedback and educational reminder

techniques in the form of a graph indicating the GP ‘referral rate’ compared to other participants and a message attached to each x-ray they requested which read “*In either acute (less than 6 weeks) or chronic back pain, without adverse features, X-ray is not routinely indicated*”. Results differed from the original trial findings in that both interventions significantly influenced simulated referral behaviour in the IME whereas only educational reminder message had this effect in the ‘real’ trial. It was suggested that the difference in results may have been due to the time delay when delivering the intervention in the IME versus the trial.

A paper-based IME adopted to target inappropriate prescribing of antibiotics for upper respiratory tract infection (Hrisos *et al*, 2008) implemented persuasive communication and graded task interventions. Participants in the graded task arm displayed no significant effect on behavioural intention to prescribe or GP’s simulated behaviour compared to the persuasive communication group who reported significant effect in both.

In both studies users were presented with baseline questionnaires followed by simulated scenarios to ascertain treatment/referral rate. Participants were then randomised to intervention or control before being asked to respond to the same questionnaire after which they were shown a different scenario set. Treweek *et al* (2008) developed this concept further; initially by demonstrating and evaluating the x-ray referral interventions presented on a web-based platform. More recently the same group replicated the antibiotic prescribing study, again through a web-based intervention but replaced the ineffective graded task which demonstrated no significant results with an alternative action plan intervention (Treweek *et al*, 2011).

Both of these trials validated web-enabled modelling experiments however they lacked web-enhanced features. Audio and video enhancements adopted in the representation of the scenarios could lead to a more immersive realistic experience. Williams *et al* (2012, CSO Ref: CZH/4/664) embraced the technology with the use of animations presented through a WIME to increase physical activity in young people with asthma.

2.6.6. Superordinate Classification

Although varying in nomenclature there is significant overlap between the various types of healthcare interventions described in this chapter. All types share a common focus of increasing knowledge; changing behaviours; providing support for chronic conditions and promoting good health behaviours. Also shared are the reasons cited for adopting a web-based delivery platform, ease of accessing the population, cost and the ability to provide enhanced functionality with the aim of leading to an engaging environment. The generic term '*Internet Intervention*' will be adopted throughout the upcoming chapters of this thesis as a collective term for interventions delivered via a web-based platform.

2.7. Intervention Development

2.7.1. User-Centred Design

“The single most important factor in realising the potential of healthcare ICTs (Information and Communication Technologies) is the people who use them. The end users of any new technology must be involved at all stages of the design, development and implementation, taking into account how people work together and

how patients, carers and healthcare professionals interact.” (The Royal Society, 2006).

The development of Internet Interventions requires a multi-disciplinary approach involving stakeholders from varying backgrounds including healthcare professionals, psychologists, statisticians, software engineers and researchers. This can be a challenging process particularly in the communication of scientific and technical ideas (Pagliari, 2007). The domain expertise provided by these groups is vital in the conception, design and future of healthcare research however, the most important group, the end users, are too often missing from the design process. While there is an understanding within software engineering of the importance of user involvement throughout the lifecycle of a software development project, in practice this is often lacking. Short timescales, financial constraints, lack of skills or simply a lack of effort culminate in a top-down approach being adopted where issues only become apparent after deployment (Dabbs *et al*, 2009). This has been a particularly common problem in the healthcare arena where systems have failed due to unforeseen issues which could have potentially been avoided with the adoption of early user involvement (Pagliari, 2007).

User-centred design is the process, by which users are involved throughout the design and development of a software product. Focusing on understanding who the users are, the tasks they need to perform and the environments they will be performed in (Stone *et al*, 2005) are basic principles. User characteristics/profiles to consider include age, sex, physical abilities, and computer experience; however the environment can also have a major impact on use of a system such as noise, stress,

public or private access. Task analysis involves understanding the complexity, frequency and duration of tasks which can be described in a goal-task-action format (Stone *et al*, 2005). Initial requirements gathering can be captured through a combination of multiple approaches such as questionnaires, focus groups, interviews or through the adoption of ethnographical methodologies. In the initial phases an investigation and evaluation of what if any software is currently used or available should be undertaken through formative or/and heuristic evaluations.

ISO 13407, Human-Centred Design Processes for Interactive Systems (ISO 1997), supports the continuous involvement of users in a multi-disciplinary design team by outlining the four main principles of human centred design as:

1. The active involvement of the user
2. An appropriate allocation of function between user and system
3. Iteration of design solutions
4. Multidisciplinary design teams

The US FDA (1997) further supports these principles by encouraging the use of iterative development, user involvement and user verification in order to ensure the creation of systems which fully satisfy the needs of the intended users.

User involvement can exist in many forms ranging from simply providing information, evaluating features or participating as full design partners in the development of a system (Damodaran, 1996). Gould and Lewis (1985) recommend early and continuous user involvement in the form of participatory design where the

user actively participates as a member of the design team, which in turn promotes a sense of ownership in the end product.

Over the years traditional software engineering lifecycles have adapted to support an iterative design process, moving away from the sequential waterfall approach (Sommerville, 1995) in which evaluation is not carried out until the latter stages of the development, towards a more flexible methodology, like the star life cycle (Hix and Hartson 1993), with a central focus on evaluation (Figure 2.6).

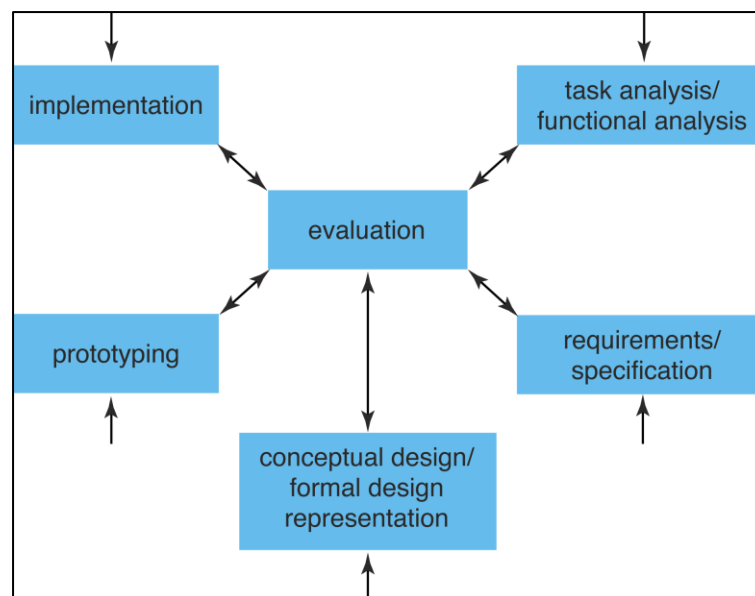


Figure 2.6 Star Lifecycle (Hix and Hartson, 1993)

Through this model users are involved iteratively in the gathering of requirements, design, evaluation and testing of prototypes followed by subsequent updates to a live system throughout the software lifespan.

2.7.2. User Interface Design

After each requirement gathering phase documentation is used to confirm the understanding of the user's prerequisites for the system. These written requirements are then translated into use cases, prototypes and ultimately the final solution.

2.7.2.1. Prototypes

Prototyping provides a cheap and quick approach to be used both in the requirements gathering and design stages. Facilitated to communicate ideas with users and test interactions; allowing for flexibility and adaptability in designs without significant development expenditure. In their simplest form low-fidelity prototypes can be paper sketches, screen mock-ups or storyboards which are very appropriate in the requirements phases. Embraced only by a few usability experts in the 1990s, paper prototyping or the 'Wizard of Oz' approach has since developed to become an integral part of interface design and testing.

“Paper prototype is a variation of usability testing where representative users perform realistic tasks by interacting with a paper version of the interface that is manipulated by a person “playing computer”, who doesn't explain how the interface is intended to work.” (Snyder, 2003).

High-fidelity prototypes used to demonstrate functionality incorporate software technology ranging from PowerPoint type presentations to programmed interfaces, used to create horizontal (present an overview of the system but with limited functionality), vertical (allows for in-depth interaction with one aspect of the full system) or full prototypes (which demonstrate the full system).

2.7.2.2. Design Techniques

Usability relates to the ease of use of an interface, defined by ISO 924-11 as “*The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in specified context of use.*”. In creating an interface which matches the user’s requirements, the following techniques should be considered to enhance usability:

2.7.2.3. Mental Models

Mental models (Norman, 1990) support ‘*recognition is easier than recall*’; when interacting with an unfamiliar interface users rely upon their past experiences and knowledge to aid the learning curve. Designing an intuitive interface which exploits both ‘*knowledge in the head*’ in combination with ‘*knowledge in the world*’ helps to alleviate cognitive load on users, thus resulting in the creation of a more usable interface.

2.7.2.4. Metaphors

In combination with mental models, design metaphors can be used to draw on the user’s existing knowledge. One familiar example of a design metaphor is Microsoft Windows, a direct manipulation graphical user interface (GUI) which uses familiar icons such as folders, printers and the calculator to represent the user’s tasks. The design of the metaphor should consider the user’s experience and the consistency of the metaphor with the physical analogue. Apple used a trash can to represent deleting files and folders a consistent, familiar metaphor however, this icon had a dual purpose also representing the functionality to eject a disk. Some users believed

the content of their disk would be deleted on selection of the trash can (Stone *et al*, 2005).

2.7.2.5. Design Principles

Interfaces should be simple, structured, consistent and tolerant in use. Stone *et al* (2005) defined four psychological principles which are too often not considered in the design of an interface:

1. *Users See What They Expect to See* – particularly relating to consistency and prior knowledge, for example buttons should be placed in the same order or colours utilised should indicate a consistent meaning.

2. *Users Have Difficulty Focusing on More Than One Activity at a Time* – this principle is associated with screen real estate and placement; grouping should be used to indicate similar things and important information placed in prominent positions.

3. *It Is Easier to Perceive a Structured Layout* – supported by Gestalt Psychology Laws of perception (Koffka, 1935) the most relevant principles in the field of interface design are the *law of proximity* where similar elements are placed close together and the *law of similarity* where the use of shapes or colours can be used to indicate similar elements.

4. *Recognition is better than Recall* – supported by the theory of ‘*knowledge in the head*’ and ‘*knowledge in the world*’ Norman (1988), it is perceived easier to recognise information than to recall it.

In combination with these principles it should also be made obvious to users what a control is to be used for, how to use it and when it has been used (Stone, 2005). An obvious example of an interface control is a button which affords being pressed, a change in design or a sound can be used to indicate the interaction, “*When affordances are taken advantage of, the user knows what to do just by looking: no picture, label, or instruction is required*” (Norman, 1988)

2.7.3. Usability Evaluation

The final stage in each iteration of a software design lifecycle involves a formative evaluation of the prototypes produced, concluding with a summative evaluation before a system is deployed. These qualitative or quantitative evaluations can involve potential users through focus groups; task-based experiments both of which encourage ‘think aloud’ methodologies, interviews or questionnaires. Domain experts should also be involved in the form of heuristic evaluations (Nielsen, 1994), measuring error prevention rate, consistency, aesthetics and help support. Although these different types of evaluation involve distinct groups the aim is the same - to identify potential usability issues.

The ISO definition of usability can be expanded to include five characteristics: effectiveness; efficiency; engagement; error tolerance and learnability, which together provide a useful set of usability metrics (Quesenberry, 2001) (Figure 2.7).

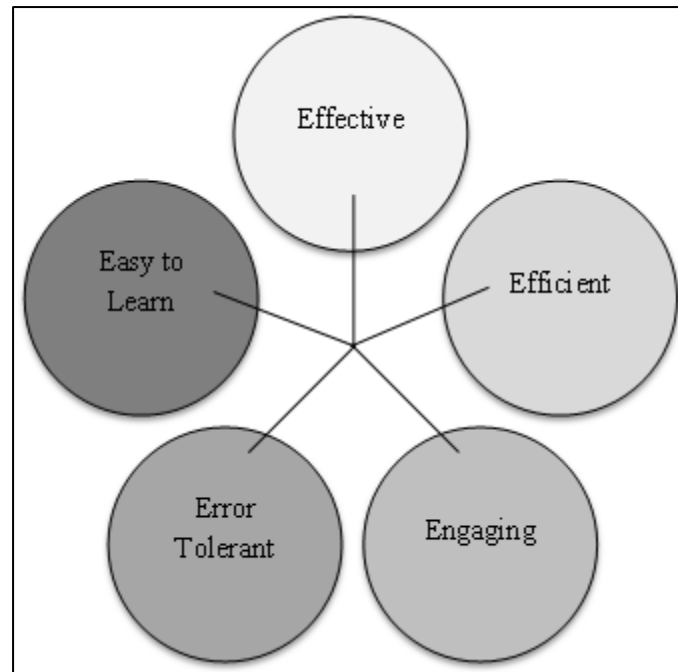


Figure 2.7 5 Es of Usability (Quesenbery, 2001)

In a usability evaluation, quantitative measurements are attributed to the 5 E's which define whether the software is:

Effective: the completeness and accuracy with which users achieve specified goals, such as: task completion; number of features used.

Efficient: time to complete task; time spent on errors; and frequency of access to help all describe how efficient an interface is to use.

Engaging: Multi-media components can help to heighten engagement levels of Internet Interventions which can be measured in terms of user satisfaction through the use of questionnaires such as the IBM Usability Questionnaires (Lewis, 1995) or the Questionnaire for Interface Satisfaction (Harper *et al*, 1993).

Error Tolerant: The system should be designed to prevent errors, measured by the percentage of errors encountered, and the number of errors recovered from.

Easy to Learn: A difficult measure to capture. Ease of learning does not only include initial barriers to learning but also subsequent learnability over time. Retention tasks can be used to measure this characteristic.

2.7.4. User-Centred Design with Internet Interventions

The Royal Society (2006) recognises the need to apply user-centred design techniques, usable interface design and rapid prototyping to the creation of healthcare interventions:

To deal with the complexities of the healthcare environment we strongly advocate an incremental and iterative approach to the design, implementation and evaluation of healthcare ICTs. This involves engaging the end users at all appropriate stages from determining the specifications through to training and ongoing support once the system is introduced. Experimentation is a major part of this approach to design and development as it allows the good and bad elements of systems to be determined and developed or dropped as appropriate. (Royal Society, 2006).

User-centred design and usability testing in the development of Internet interventions is often not performed, or only partially implemented by involving users at the evaluation stages rather than throughout the design process. The publication of trial results rarely or only sparsely provide a description of the usability techniques adopted, if any, with limited findings presented (Dabbs *et al*, 2009).

Yuan *et al* (2013) describe a usability evaluation of a clinical decision support system (CDSS) focused on early symptom recognition and response. User-centred design techniques were only partially implemented through the identification of system users, profiles and task analysis based on interviews. User feedback was only incorporated at the evaluation stages rather than throughout the lifecycle. The design metaphor of a checklist was implemented; embracing the '*knowledge in the head*' of this user group; however there is no indication of low-fidelity prototypes or multiple design iterations. The system design described as iterative followed a two stage process with a heuristic evaluation carried out after the first iteration; the user evaluation was not undertaken until after the first release of the system. Metrics collected included task completion, completion time and cognitive load which represent three of the five E's – Effectiveness, Efficiency and Ease to Learn.

Kreps and Neuhauser (2010) identified four communication directions for designing health information technologies (HITs) based on maximising interactivity, cross platform implementation, personal engagement and user reach. The focus was to maximise the potential of HITs. Although user-centred design was mentioned it was not documented as one of the major directions attributed to maximisation of health information resources, similarly evaluation was not described as a factor.

Patients and caregivers welcome the potential of Internet Interventions as a resource for chronic conditions, however many interventions are not delivering to their full potential (Kerr *et al*, 2006). Through user involvement Kerr *et al* identified user-generated criteria to be considered in the design of Internet Interventions which best

suit the users' needs including information content, evolving needs, scientific uncertainty and presentation.

Similar to Kreps and Neuhauser, Riiser *et al* (2013) involved users in the evaluation stages of the development of an Internet Intervention to increase physical activity in overweight adolescents. However although described as “*valuable creative partners in the developmental process*” there was limited user involvement in the design stages which consisted of a single workshop. An interdisciplinary team was formed; however this did not include any representative users.

Atkinson *et al* (2009) employed an iterative user-centred design approach, with early and continuous user involvement, in the design of a nutrition education website for mothers living in a rural area. The three phase iterative cycle included initial acceptability of the website as a concept, decisions about the design of the components which should be included in the website and finally the usability testing of the final prototype website. Prototypes were iteratively developed based on feedback from the previous stages and the usability findings were incorporated into the final website before it was launched.

Both Dabbs *et al* (2009) and Thursky and Mahemoff (2007) adopted user-centred design techniques in the development of an intervention to promote self-monitoring in lung transplant patients (Pocket PATH) and a decision support system for antibiotic prescribing in the intensive care (ADVISE) setting respectively. Initial requirements gathering involved observational methodologies in the field capturing both user profiles and task analysis information. In the next stage low-fidelity paper

prototypes were created and evaluated adopting think-aloud techniques. Dabbs *et al* then adopted an iterative software prototyping cycle carrying out both laboratory and field evaluations, whereas Thursky and Mahemoff translated the feedback from the paper prototype into the final software product missing out software prototyping “*avoided the time and cost associated with software prototyping*”. Dabbs *et al* employed the IBM After-Scenario Questionnaires and Post-Study System Usability Questionnaires to calculate a user satisfaction measure. ADVISE was rolled out in January 2002 and led to a 10.5% reduction in overall antibiotic usage and a reduction in the number of patients prescribed broad-spectrum antibiotics. Pocket PATH was piloted in a randomised-controlled pilot trial where patients found the tool superior to traditional methods for self-monitoring after transplant.

2.8. Summary

Internet interventions have been shown to be effective in the healthcare field particularly in the management of chronic illness, disease prevention and sensitive health topics such as sexual health. The Internet provides an accessible platform for the deployment of interventions by opening up healthcare information to the wide population. The number of users accessing the Internet is increasing on an annual basis. Being able to access health services remotely is potentially beneficial to those living in rural areas who, experience difficulties where resources are limited. The Internet enables access to large quantities of information in a format which can be broken down into manageable pieces and displayed in ways, which are attractive to the users through embracing multimedia functionality. Although the cost of rolling out Internet interventions is thought to be relatively low, the development and

maintenance costs should be considered and fully documented. Currently, developing Internet interventions requires a multi-disciplinary team including a software developer due to a lack of an accessible, suitable tool for researchers. There are multiple naming conventions for healthcare interventions delivered over the Internet which can be grouped under the collective term Internet Interventions. In order to design usable Internet Interventions user-centred design methodologies, interface design principles and usability testing need to be adopted, however this is often found not to be the case in the design of healthcare systems.

Chapter 3 Developing Internet Interventions: Case Studies

3.1. Introduction

Understanding project requirements, identification of the multiple multi-disciplinary stakeholders involved and focusing on participatory design techniques are the fundamental first steps to be undertaken in the development of healthcare Internet Interventions.

Three case studies in the fields of obstetrics, dentistry and psychiatry detailed in this chapter illustrate the development of healthcare Internet Interventions created by the author as part of multi-disciplinary project teams.

1. Decision Aid for Mode of Next Delivery (DiAMOND)
2. Dental Clinical Pathways
3. Decision Aids for Depression (DECADE)

Translating the intervention requirements for these projects into software interventions, in addition to 8 subsequent interventions provided the author with insights into the common elements shared between Internet Intervention requirements and user profile definitions. It also highlighted the lack of useable software tools for researchers in the creation of Internet Interventions. The following sections discuss each case study describing the project team; study design; intervention development and evaluation, concluding by identifying commonalities shared across all three studies.

3.2. Case Study 1 - Decision Aid for Mode of Next Delivery (DiAMOND)

3.2.1. Background

The three year DiAMOND Study (Montgomery *et al*, 2004) funded by The BUPA Foundation, consisted of a randomised controlled trial (RCT) of two web-based interventions for mode of delivery, among women with a previous caesarean section. The focus of this research was to not only address the rising UK caesarean rates highlighted in The Changing Childbirth Report (London, HMSO, 1993), but in response to the evidence-based guidelines commissioned by the National Institute for Clinical Excellence (NICE Health, 2004), which emphasised the need for patient preference in relation to the management of pregnancy and childbirth. The project team consisted of obstetric specialists, doctors, research staff, patient representatives, software developers and human computer interaction specialists based at two sites within the Universities of Dundee and Bristol.

3.2.2. Study Design

The aim of the study was to evaluate the impact of two interventions, to aid decision making regarding mode of delivery, among women with one previous caesarean section. A three arm comparison experiment was conducted involving two interventions and usual care with outcome measures including decisional conflict; actual and attempted mode of delivery; anxiety; knowledge; perception of shared decision making and satisfaction with the decision making process.

The trial sample comprised of pregnant women with no current obstetric problems, whose most recent delivery was a lower segment caesarean section. Exclusion criteria included women with limited ability to speak or understand English. The study took place between May 2004 and January 2006 in three maternity units in south west England and one in Scotland. The caesarean section rates at these units were representative of the national rate ranging from 22% to 25%. Women were recruited by a research midwife during their initial booking visit, where they received an information sheet, consent form and baseline questionnaire. Following baseline assessment the women were then randomised based on maternity unit and preferred method of delivery to either:

- Usual care – the control group where the normal level of care was provided by the obstetric and midwifery team.
- Information Website – supplementary to usual care, provided additional information and probabilities on the possible outcomes associated with planned vaginal delivery, elective caesarean section and emergency caesarean
- Decision Analysis – again in combination with usual care, contained the same information as the information website, but with the removal of probability values. The women were asked to consider the value they attached to possible outcomes which affected themselves or their babies, through rating each possible outcome on a visual analogue scale from 0 to 100. Examples of such outcomes included baby breathing difficulties, surgical damage and incontinence.

3.2.3. Study Results

1148 women were invited to participate in the study with 742 randomised; data was obtained for 600 women relating to decisional conflict scale and 713 women for mode of delivery. Qualitative and quantitative study results are discussed in more detail elsewhere (Montgomery *et al* 2007, Emmett *et al* 2006) however the main trial findings report computer based intervention can result in a greater reduction in decisional conflict; lower anxiety and greater knowledge among pregnant women with one previous caesarean section, compared to that of usual care. Decision analysis was also shown to be associated with a higher proportion of women achieving a vaginal delivery.

3.2.4. Intervention Development

This project required the development of two software interventions, a web-based information resource and a desktop decision analysis tool preloaded onto a laptop, to be utilised by the research nurse at patient home visits.

3.2.4.1. Requirements Gathering

Heuristic Evaluation

To gain background knowledge in the area of decision analysis tools and health related information websites heuristic evaluations (Nielsen, 1994) were carried out on two similar interventions, developed for different healthcare topics. The evaluations were carried out by the author and a fellow software developer who specialised in website usability and accessibility.

- Clinical Guidance Tree Program (CGT), a computerised clinical guidance tree for benign prostatic hyperplasia and hypertension (CSO March 2000-June 2003). The software development group within the DiAMOND project team visited the development site at Stirling University to discuss the development of CGT.
- Former DIPex Website (www.dipex.org, 18/08/03), produced by various health professionals aimed at providing patients, their families or carers with access to medical resources.

While the evaluators could not comment on the medical value of either of the interventions as tools for aiding treatment decisions, focusing on interface usability and design the review concluded:

- Overly technical information was presented for the target audience
- Navigation was inconsistent and confusing
- Screen design was busy and cluttered

3.2.4.2. Design

Both the information website and decision aid were developed iteratively adopting a rapid prototyping methodology with continuous user involvement.

Prototypes

a) Horizontal Prototype

Based on the project requirements and background insights gained from the heuristic evaluations a basic horizontal prototype was developed in HTML (Figure 3.1). As outlined in Chapter 2 a horizontal prototype provides the flow through the system

but with limited functionality. They provide navigation facilities to allow the user to view screen content, but with no underlying processes. This prototype was used as a basis for discussion within the project group and to confirm the project requirements.

Pros and Cons of Trial of Labour and Elective Repeat Caesarean Section	
Trial of Labour	Elective Repeat Caesarean
Pros: - Quicker recovery - Less risk of complications for both mother and baby Cons: - Risk of uterine rupture Complications: Explanation of what complications means and the outcomes for mother and baby - Major: list of major complications - Minor: list of minor complications	Pros: - Less risk of uterine rupture Cons: - Longer recovery period - More risk of complications for both mother and baby Complications: Explanation of what complications means and the outcomes for mother and baby - Major: list of major complications - Minor: list of minor complications
Click on the video icon to see someone talking about their experience of a trial of labour  Click on the camera icon to see the trial of labour photo gallery 	Click on the video icon to see someone talking about their experience of an elective repeat caesarean section  Click on the camera icon to see the repeat caesarean section photo gallery 
Back	Next

Figure 3.1 Pros and cons of the vaginal vs. elective caesarean section

Two alternative rating interfaces were developed, again to prompt discussion within the project team regarding the most user friendly way to collect this information (Figure 3.2).


Your Ratings	
Best(100)  Worst(0)	Please rate each of these scenarios on a scale of 0-100, where 0 is worst and 100 is best. These ratings will then be used to calculate the best mode of delivery for you Elective Repeat Caesarean without complications: <input type="text"/> Elective Repeat Caesarean with minor complications: <input type="text"/> Elective Repeat Caesarean with major complications: <input type="text"/> Successful Trial of Labour without complications: <input type="text"/> Successful Trial of Labour with minor complications: <input type="text"/> Successful Trial of Labour with major complications: <input type="text"/> Failed Trial of Labour without complications: <input type="text"/> Failed Trial of Labour with minor complications: <input type="text"/> Failed Trial of Labour with major complications: <input type="text"/> Repeat caesarean section without complications: <input type="text"/> Repeat caesarean section with minor complications: <input type="text"/> Repeat caesarean section with major complications: <input type="text"/>
	Back Next

Figure 3.2 Alternative prototype interfaces to capture participant ratings

The horizontal prototype served the main purpose of confirming the project requirements with all collaborators, and in conjunction with the heuristic evaluations served to progress to the next iteration of the vertical prototype.

b) Vertical Prototype

This type of prototype provides full functionality but only for sub-components of the system. At this stage the decision was made to change the implementation tool to Flash MX instead of HTML, as Flash provides a platform for quicker prototype creation. The main findings in the heuristic evaluations related to navigation and quantity of information displayed on screen. To avoid a potential overload a tabular layout was designed for both the information website and decision analysis tool, which in combination with the styling provided a consistent identity across the project. Analogous to that of a folder with section dividers, the tab metaphor was implemented to aid user interaction with the interventions through a familiar format (Figure 3.3).

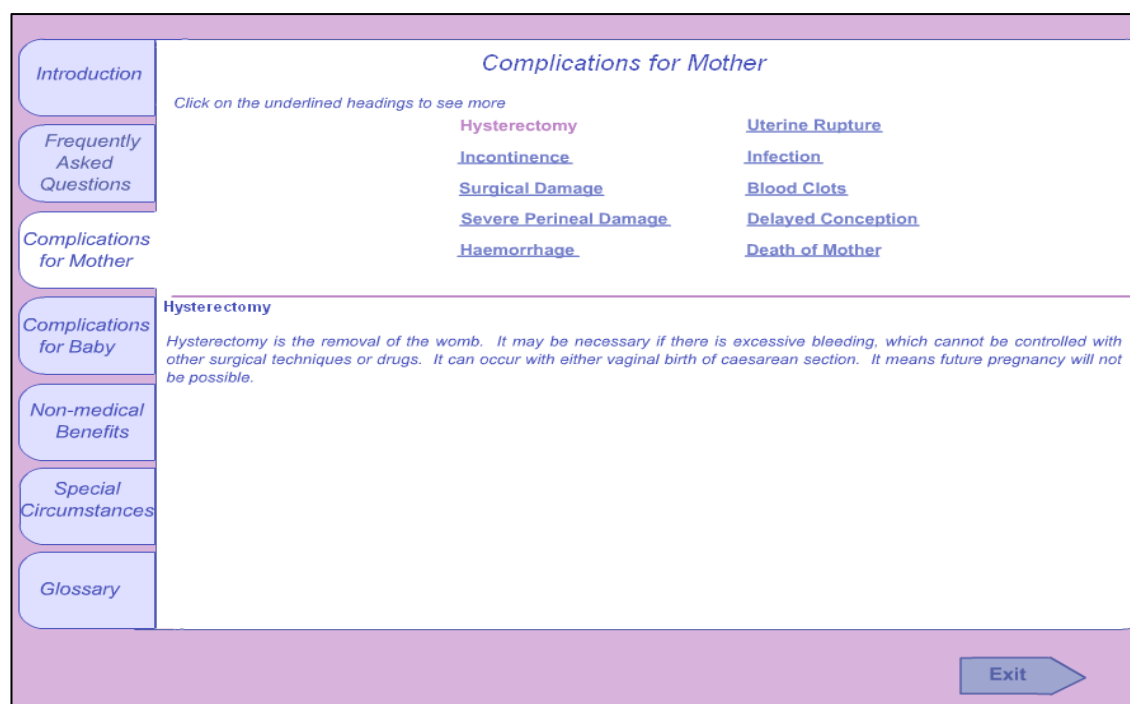


Figure 3.3 Tabular Navigation Menu

Both the information website and decision analysis tool were split into: frequently asked questions; complications for mother; complications for baby; non-medical benefits and special circumstances. The decision analysis tool had a subsequent section where the women were asked to rate both the possible health complications (Figure 3.4) and mode of delivery (Figure 3.5) based on their own unique viewpoints.

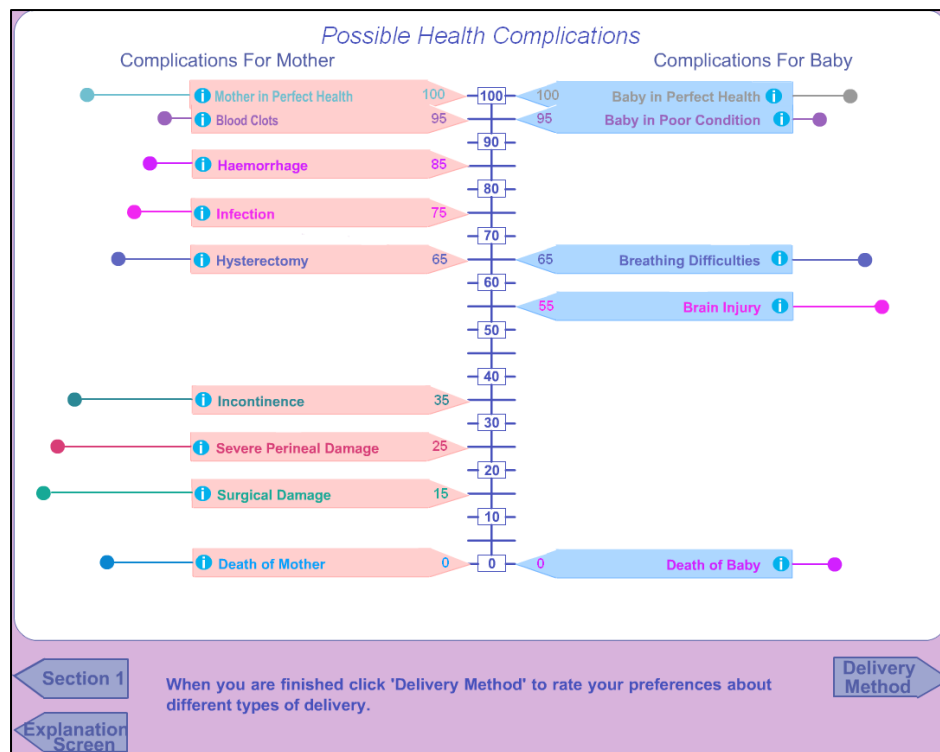


Figure 3.4 Outcome Rating Chart

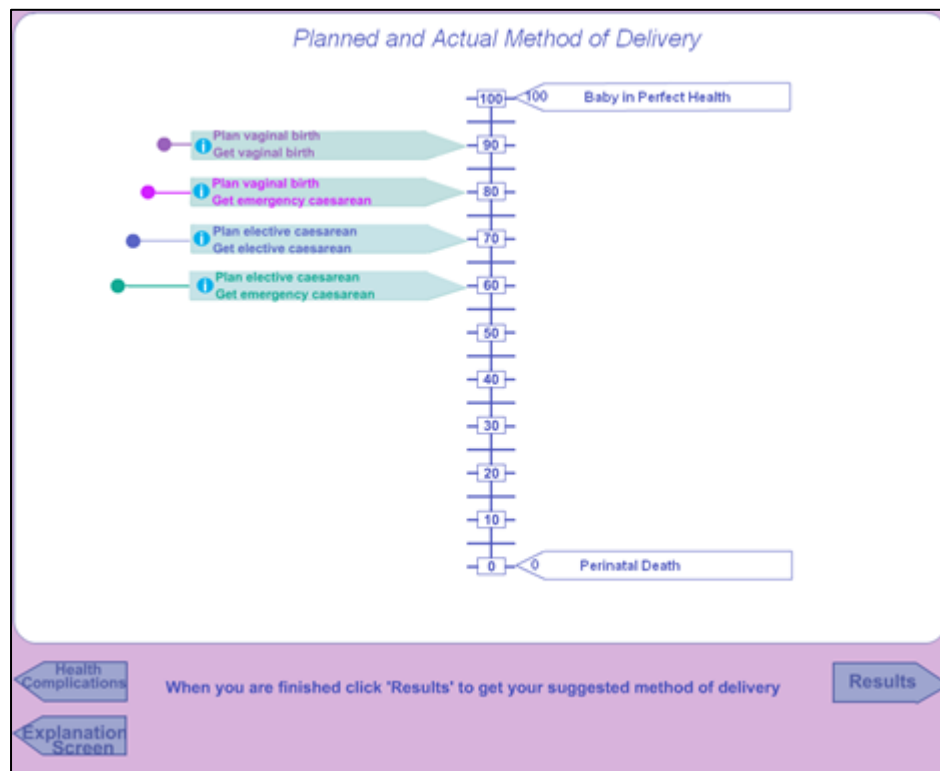


Figure 3.5 Mode of Delivery Rating Chart

The functionality added in the vertical prototype included the addition of the underlying decision tree, implemented using TreeAge Software

(<http://www.treeage.com>) with a Visual Basic ActiveX component. This functionality calculated the women's preferred method of delivery by combining the utility values for each of the possible outcomes with the women's rating for the same outcomes.

The vertical prototype was then evaluated by the project team where three main recommendations were identified, with the potential to enhance the user experience:

- Provide a glossary facility (both interventions)
- Incorporate a practice rating screen (decisional analysis tool)
- Addition of probability values (information website)

c) Full Prototype

The suggestions raised through the vertical prototype evaluation and remaining functionality were then incorporated into the interventions including:

Glossary

In addition to the glossary feature, any word which was felt not to be of the average reading age as defined by the FOG Index (Gunning, 1969), had a pop-up box definition attached to them. Similarly pop-up box functionality was added to the outcomes on the rating scales to provide the women with a clearer understanding on the possible outcomes and thus aid the women in making a more informed rating.

Practice Screen

The project team felt that the women might find the rating scale a difficult concept to comprehend; ultimately they were being asked to rate possible health outcomes for

mother and baby on a scale with anchor points of perfect health to death. The most appropriate solution was the addition of practice questions which could be manipulated and used to validate their understating of the rating scales. The practice question asked if they would prefer if their baby was a boy or a girl or if they were unsure (Figure 3.6).

Section 2 - Practice Session

This is a practice session and is not related to your preferred mode of delivery, but simply to allow you to practise using the rating scale and answering questions.

Before going to the practice rating scale, please answer a question about your preference for having a boy or a girl. Would you prefer to have:

A boy ☐ Please select one circle
A girl ☒
I don't mind whether i have a girl or a boy ☐

Now click on Ok to go to the practice rating scale.

Ok

Figure 3.6 Practice Question

This was used to corroborate their rating on the following scale, i.e. if they preferred to have a girl it would be above the boy outcome on the rating scale (Figure 3.7).

Sex of Your Child

To make sure you are clear about how to move outcomes on the scale, we are asking you to rate the preferred sex of your baby. Please be consistent with your previous answer.

To move the sexes click on the coloured balls at the end of each and drag to your preferred position on the scale, where 100 would be your most preferred outcome, and 0 your least preferred.

When you have finished rating the sexes simply press ok.

71 Girl

43 Boy

Ok

Figure 3.7 Practice Question Rating Scale

Displaying Probability Information

It was decided that the information website could be further enhanced with the provision of probability information. However as discussed in Chapter 2 risk terminology and numerical probabilities can be problematic. It was therefore important to present the information clearly to avoid the potential for cognitive overload. As the software was still in a prototyping stage this provided the opportunity to investigate alternative risk presentation formats and ask potential users which they preferred/found easiest to comprehend. Three formats were therefore incorporated in the form of numbers/textual, figures and pie charts.

Logging

Logging was added to each section, button and link in both interventions to be used for audit purposes such as monitoring how often pages were viewed and how long was spent on each page. This was useful for highlighting potential problem areas and following user's flow through the intervention.

3.2.4.3. Implementation

Pilot Study

During February to April 2004 a two week pilot study was carried out in the homes of 15 postnatal and 11 antenatal women at both Bristol and Dundee sites (Emmett *et al*, 2007). The main themes arising from the pilot included:

Interventions - Feedback

Most women recognised the benefits of computer-based intervention delivery and found the content of both interventions useful and informative.

“Yeah, it’s very good; it explains it all very well, saying what can happen.”

(Antenatal Participant 3, Decision Aid)

“It’s quite nice, you know, because you might not be interested in lots and lots of it. So the fact that you can sort of click about [is good]” (Postnatal Participant 1, Information Website)

Presentation of Health Risks and Benefits

As discussed the pilot provided a platform for evaluating the three candidate presentation formats which represented the outcome probability statistics. The pilot findings concluded that there was a preference expressed for all three formats and the women liked having the choice of alternative presentations.

“I really like that; I really like that pictorial representation of all the people.

That really makes it very clear for me” (Postnatal Participant 2, Information Website)

“Certainly having the figures is reassuring, very much so, because it makes you notice what a small chance there is”. (Postnatal Participant1, Information Program)

Usability

Generally the participants found both interventions easy to use. However there were three areas identified specifically in the decision aid which proved to be problematic:

1. Navigation

Skipping Sections

Some women unintentionally overlooked some sections of the intervention, or progressed to the second rating scale without moving all of the outcomes on the first scale.

To address these issues the following functionality was incorporated into the final version of the software:

1. More detailed instructions were added to the first section
2. Validation to ensure all outcomes on scale one are moved before allowing the women to proceed to the subsequent rating scale.

2. Rating Scales

Although the participants seemed comfortable with the concept of the rating tasks, in practice this task was identified as an area of confusion by some women.

“So 100 is good then?” (Postnatal Participant 13, Decision Aid)

“I am hopeless at these sort of scales things..” (Postnatal Participant 4, Decision Aid)

To alleviate these issues an animation was developed to show the women how to rate the outcomes on the scale. Further validation was added to ensure the women were rating the outcomes suitably based on the appropriate scale anchors.

3. Repeat Access

Although the information was broken down into sections some women found the quantity of information too much to absorb in one session and a few expressed an interest in sharing the content with their partners.

“I think it would be really nice to be able to print it out, or come with it ready printed out to leave as reference material. Because it would be difficult to remember all the statistics wouldn’t it, because there’s quite a lot in there....”

(Antenatal Participant 8, Information Website)

Password protection was added to the information website to allow for multiple accesses, logging was also added to monitor the extent to which this functionality was used. The decision aid remained one access only to prevent the women manipulating the preference scores to produce different outcome results.

Additional Enhancements:

Based on the women’s feedback two additional features were also incorporated:

- **Print Functionality** – allowed the women in the decision aid arm to print their preference results which could then be taken along to their obstetrics appointments for further discussion.
- **Home Births** – Information on this topic was not previously covered in either of the interventions

3.2.5. Randomised Controlled Trial

The collection of user feedback for both interventions continued throughout the randomised controlled trial (RCT), where twenty women provided feedback on the decision aid and thirteen on the information website. Similarly to the pilot study the general feedback was found to be positive. The findings reported that the information was provided in a clear, informative, well-structured manner; both tools were user-friendly, easy to follow and provided good explanations of medical jargon. The women felt that the software prompted conversations with their health professionals which they normally wouldn't know to ask about providing a good "discussion base".

"Factual information was more frank than discussions I have had with healthcare professionals who gloss over the complications/risks, which makes it harder to come to a decision. Program will help me push harder for proper information from health carers" (ID 31105 DA)

"Had lots of new information, informative. Easy to use. Used clear language. I think it will be very useful to women in my position as I have looked everywhere (Internet, library) for this information and only found a quarter of what I saw in the program" (IW 31094).

3.2.6. Recommendations for Further Work

Issues still remained relating to the understanding of the rating scale anchors, even with the additional animation and detailed instruction, the rating on a scale of life to

death was found to be confusing. An alternative suggestion discussed altering the anchors to a scale of “*I would be thrilled*” down to “*I would be devastated*”.

The majority of women in the decision aid group requested a preference to view the probability information displayed for the various outcomes similar to that of the information website group. They found it quite difficult rating outcomes without knowing how likely each one was of occurring and to what extent the complications would affect them.

“It does not specify or allow for variations within certain choices, i.e. incontinences is an inconvenience short term but much more distressing long term” (ID 33074)

“When choosing how you feel about complications you do not know what the ultimate prognosis might be e.g. blood clots may be entirely resolved within days or may result in death – impossible to properly rate your preferences” ID (31105)

3.2.7. Summary

The DiAMOND study involved the development of two computer-based interventions, an information website and a decision aid. The interventions were developed within a multidisciplinary team, with input from service users through twelve iterations, over a period of nine months. A pilot study was conducted to establish the acceptability of the interventions with their target population which identified usability issues which were addressed ahead of the Randomised Controlled

Trial (RCT). The processes used were consistent with the MRC framework for the design and evaluation of complex interventions to improve health. The information website can be accessed through the health talk online website (http://healthtalkonline.org/Pregnancy_children/Making_decisions_about_birth_after_caesarean/Topic/2038/diamond, 07/03/2014).

3.3. Case Study 2 – Dental pathways

3.3.1. Background

In 2002 following the publication of Options for Change, the Department of Health (England) commissioned the development of the first clinical dental care pathway: the Oral Health Assessment (OHA). For its time this was perhaps the most radical dental document relating to service structure change and dentist remuneration since NHS Dentistry was conceived in 1948.

According to the Department's brief, the assessments should act as the 'gateway to NHS Dentistry' and in a change to current practice, should focus on prevention of disease, lifestyle advice, and promote shared decision making regarding possible treatment options and timescales as defined by The National Institute for Clinical Excellence (NICE) Guidelines.

M. Seward, former Chief Dental Officer England, Department of Health 2002 defined a care pathway (Figure 3.8) as:

“A documented sequence of effective clinical interventions, placed in an appropriate time frame, written and agreed by a multidisciplinary team. They help a patient with a specific condition or diagnosis move progressively through a clinical experience to the desired outcome”

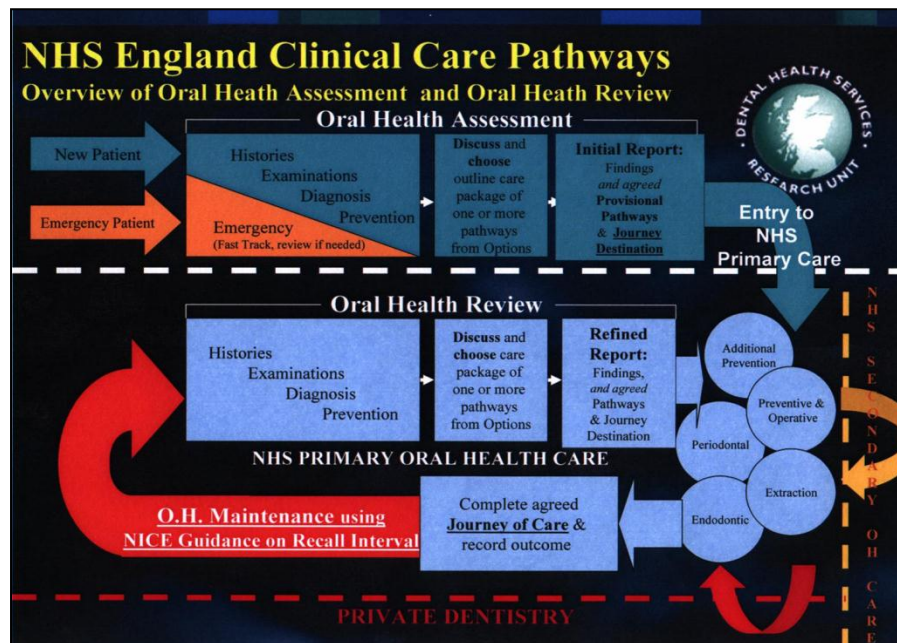


Figure 3.8 Clinical Care Pathways (NHS England)

Care pathways are not substitutes for professional clinical judgement, but simply a means of structuring and documenting the decision process gone through with the patient before deciding on an appropriate journey of care for that individual. Although a certain amount of variation is important in terms of pathway individualisation, unnecessary variation can undermine overall general practice standards, something that care pathways aim to reduce. Pathways help the professional to deliver more consistent, higher quality dental care. However sometimes deviation from the set pathway may be required.

The variance record helps to keep the pathway patient focused. It does this by tailoring care to meet patients' individual needs, and in doing so allows patients to be better informed and feel empowered about their role as a partner in decision making.

The author was part of a multidisciplinary team consisting of:

- 14 members of a clinical advisory group, commissioned to oversee the pathways algorithms development. This group contained a patient representative, primary care professionals, representatives from dental specialities, academics and members with a special needs/care focus.
- Staff from the Dental Health Services Unit, University of Dundee.
- An evaluation group of 64 dentists remotely located at four Option for Change field sites spread across Birmingham, Manchester, Liverpool, and London.
- Four members of a software development team from the School of Computing, University of Dundee.

3.3.2. Project Design

The software development phase of the project took place between October 2003 and March 2005 with the aim of developing and evaluating two linked web-based software prototypes which incorporated the functionality as defined by the oral health assessment algorithms. The software consisted of:

- A patient questionnaire – a data collection tool where patients provided personal details, medical, dental and social history.

- The Oral Health Assessment (OHA) – initially serving as a review of the patient questionnaire before guiding the dentist through various stages of examination and review including extra-oral, intra-oral, diagnosis, prevention, concluding with a care plan.

By combining the results from both sections, the underlying algorithms indicated recommendations for the next stages of care within a NICE applicable timescale range. Adopting a shared decision making process based on the recommendations of the dentist followed by shared discussion with the patient.

From the offset it was recognised that completing both the patient questionnaire and OHA would initially be a time consuming process however on subsequent visits it would simply be a case of reviewing and updating the record with any changes.

A Fast Track or minimised subset of both the interventions was developed to cater for emergency admissions.

3.3.3. Project Results

The software produced in this project was developed and evaluated by both stakeholder groups, patients and dentists both locally and at the remote field sites. The project deliverables was prototype systems. Unfortunately, on project completion there was a change of health minister which resulted in the development being put on hold. Latterly meetings were held with two commercial companies

Software of Excellence and Kodak to discuss taking the prototype forward. In addition to the software output for this project a paper version of both the patient questionnaire and OHA was also produced.

3.3.4. Intervention Development

The project involved the development of two web-based software prototypes to be utilised by two distinct user groups, members of the general public or their carers and dental health professionals.

Patient Questionnaire

The design of the patient questionnaire had to consider the following: patient privacy; self-consciousness relating to the entry of personal dental, medical and social history within the constraints of a public waiting room; diversity of the user group varying greatly in age, computer skills and abilities.

Oral Health Assessment

The OHA was to be accessed often within a busy, confined dental surgery which could be cramped with multiple members of staff, patients and possibly parents, children or carers. A tool developed for use in this type of environment must be easy to use and nonintrusive to avoid shifting the focus from the patient. Hygiene issues which could result in possible contamination had to be considered, such as when dentists are required to enter data, when gloves are worn and which stages of the OHA intra-oral examinations are completed.

Remote Collaboration/Evaluation

To alleviate the potential communication/divide difficulties encountered by both a distributed project group and evaluation sites and to support testing and evaluation a bulletin board (<http://phorum.org>) was produced (Figure 3.9). The bulletin board provided an online message service allowing members to communicate by posting or replying to posted messages. The bulletin board also supported file attachments. The standard download template was adapted to suit the users' needs by simplifying the screen content and terminology. A facility was added to allow board members to tailor email notification alerts setting alerts for new postings or topics.

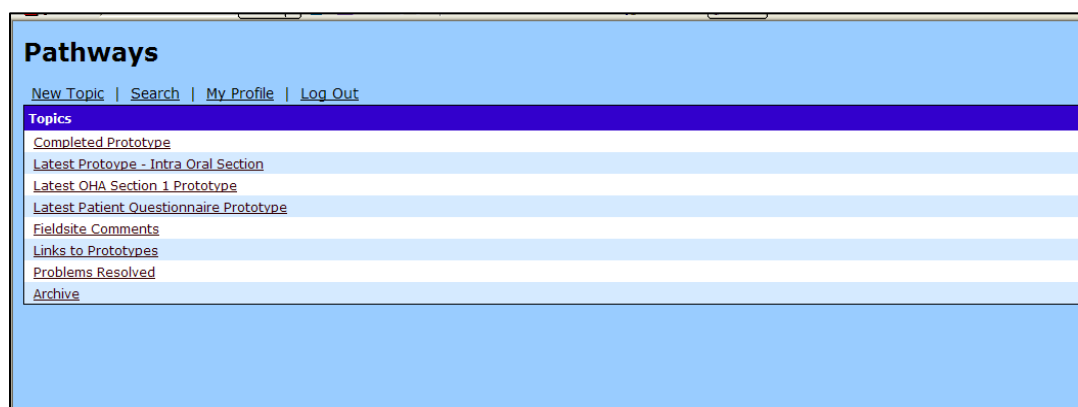


Figure 3.9 Bulletin board to aid disperse sites

Two boards were created, one for the clinical advisory group and an additional separate board for the field sites. The development team and domain experts were members on both boards. The bulletin boards fulfilled a number of roles, by providing a vehicle for feedback on the prototypes; a discussion area for possible implementation improvements and as a means to obtain opinion on new ideas. Initial usage training was provided in the form of an instruction document including a task where each member was asked to introduce themselves to the group to ensure basic functionality was understood. Optional anonymity of user comments eased concerns when providing feedback (Figure 3.10).

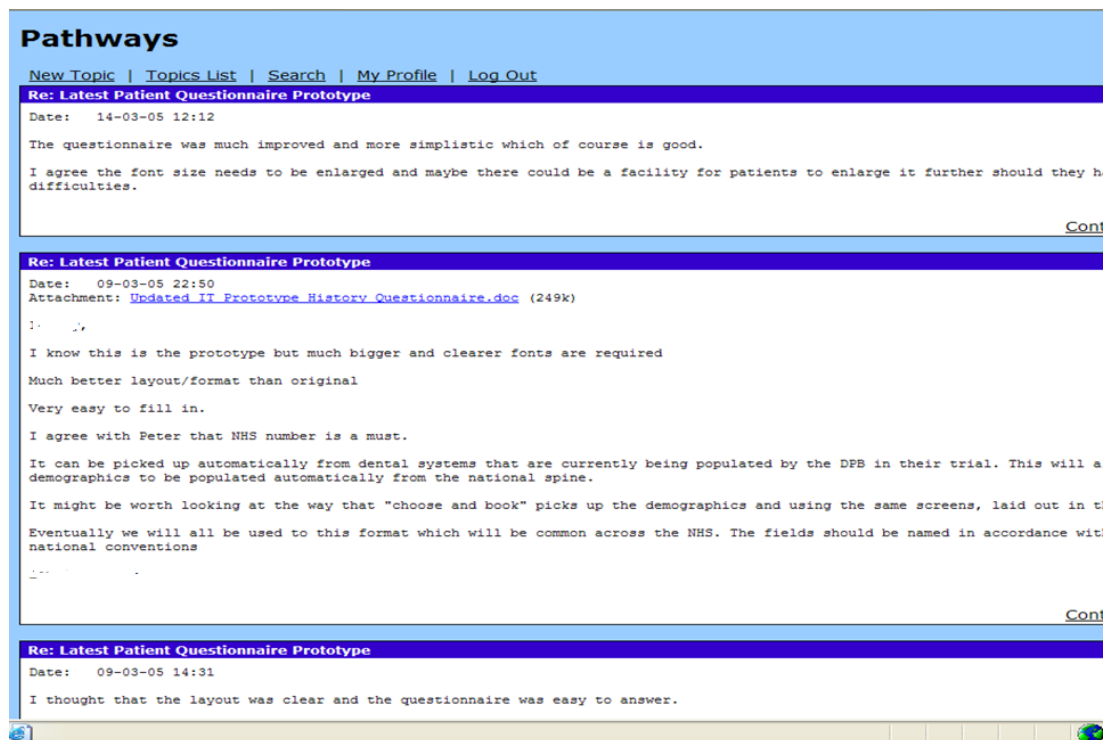


Figure 3.10 Example of prototype feedback through the bulletin board

3.3.4.1. Requirements Gathering

Ethnographic Field Study

As part of the initial background requirements gathering an ethnographic field study was undertaken at Dundee Dental Hospital, where mock patient examinations were observed by the software development team. This provided an understanding of typical examination scenarios, identified when gloves were worn and highlighted the dentist's position throughout the consultation.

Existing Tools

The next stage involved the evaluation of existing tools by means of a two-step process:

1. Heuristic evaluations were carried out on existing dental software solutions (Dentrix, BridgeIT, Software for Excellence, Practice Works, and Oral Age) with a

specific focus on software usability. The purpose of the evaluations was to identify the common functionality required from a data collection tool in this field and also to ascertain the most commonly used packages.

2. User testing was undertaken at Edinburgh Dental Hospital where dentists were asked to '*think-aloud*' (Nielsen, 1994) while using the software.

The central finding from both evaluation types was the unfamiliarity of coding and symbols used in the software packages for charting. The symbols and codes adopted did not follow standard dental nomenclature, thus requiring additional cognitive effort from users in order to use the software. This resulted in inconsistencies and incompatibilities between software packages and training requirements for dentists with no prior exposure to the software.

3.4.4.2. Design

Data Entry Methods

Given the varying user groups, possible contamination and space limiting considerations a speech recognition package was briefly considered for data entry by both patients and dentists. However this was quickly dismissed due to privacy concerns relating to personal information, practical issues including busy practices, noisy equipment and sensitivity fears regarding examination diagnosis. Alternatively a touch screen with minimum text entry was identified as a more suitable approach.

Prototypes

Similarly to Case Study 1 a rapid prototyping methodology was adopted. This method was extremely beneficial in this project as the requirements were constantly evolving throughout, resulting in frequent software changes and the necessity for regular confirmation and evaluation. Evaluations were carried out on each iteration of the software by means of the bulletin board in the form of a structured questionnaire followed by an open comment forum. Final focus group evaluations were held with both patients and dentists.

3.4.4.3. Paper Prototype

Initial investigatory stages of the project were led by the clinical advisory group in the review of the current evidence base focusing on best practice. This served to establish the accepted criteria to be adopted in the OHA. The evidence base was then translated into a process map or algorithm which ultimately formed the initial paper prototype in the design of the OHA (Figure 3.11).

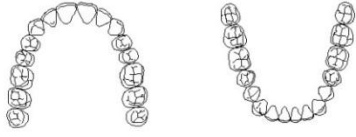
The Denture Assessment		Page 10
Denture Description		
<input type="checkbox"/> Patient does not have a denture	Teeth on denture: _____	Variance <input type="checkbox"/>
	Denture material: <div> <input type="checkbox"/> Cobalt chrome <input type="checkbox"/> PMMA <input type="checkbox"/> Other specify: _____ </div>	
Current Denture Design (Optional)		
		Variance <input type="checkbox"/>
Denture Information		
Patient happy with their current denture/s: Yes <input type="checkbox"/> No <input type="checkbox"/>		Variance <input type="checkbox"/>
Age of denture: Upper <input type="text"/> Lower <input type="text"/>		
Length of time patient been denture wearer: <input type="text"/>		
General Denture Assessment		
Dental Professional's opinion of each denture		Variance <input type="checkbox"/>
Upper denture <input type="checkbox"/> Adequate <input type="checkbox"/> Inadequate Lower denture <input type="checkbox"/> Adequate <input type="checkbox"/> Inadequate		
Variance Record (Details)		

Figure 3.11 Practice Question Rating Scale

Adopting a divide and conquer approach the algorithm was further split into four smaller subsections detailing the procedures involved in the assessment. Each section was individually evaluated and formed the basis for developing the software prototypes.

3.4.4.4. Horizontal Prototype

Skeleton frameworks for both the patient questionnaire and OHA were produced to confirm the understanding of the algorithm requirements (Figure 3.12) and to identify the flow through the software.

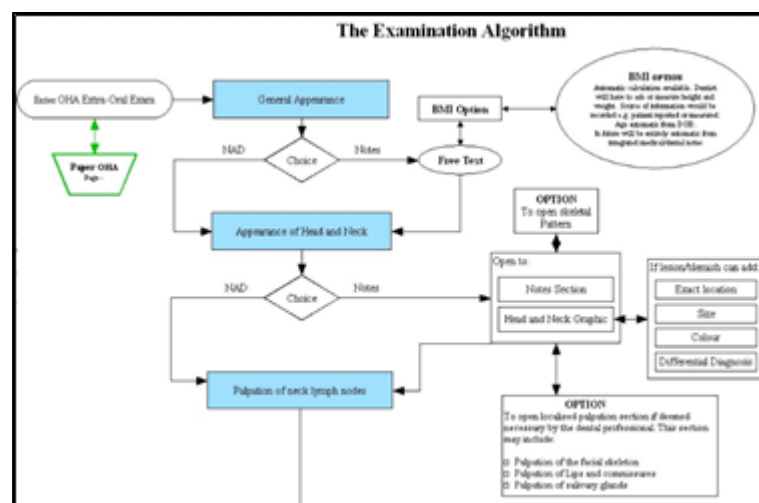


Figure 3.12 Snap shot of the examination algorithm of the OHA

The first patient questionnaire prototype was presented in the form of an HTML website, whereas the OHA was developed using Flash MX technology. The patient questionnaire was designed with one question displayed per page (Figure 3.13). However this was found to be too time consuming and cumbersome, further exacerbated by the heavy reliance on keyboard data entry.

The image shows a horizontal prototype of a patient questionnaire screen. The screen has a light blue background. At the top left, it says "Question 2 of 6". At the top right, there is a button labeled "Click here for Help". The main content area is a white rectangle with a blue border. It contains the question: "2) Are you allergic to anything you know of? (Penicillin or another antibiotic, pollen, latex or any other substance)". Below the question are three radio buttons: "Yes" (selected), "No", and "Unsure". Below these is a "Sub Question:" section with the text "Please specify: (tick the ones that apply)". This is followed by a list of items with checkboxes: "Penicillin" (unchecked), "Other antibiotics" (unchecked), "Pollen" (unchecked), "Latex" (checked), and "Other" (unchecked). At the bottom left of the white area is a "Next >" button. At the bottom right of the white area is an "End Interview Now" button.

Figure 3.13 Patient Questionnaire Horizontal Prototype

3.4.4.5. Vertical Prototype

Based on user feedback the design of the patient questionnaire was re-evaluated, the decision was made to develop it similarly to the OHA using Flash MX in combination with PHP and MYSQL and to group and display multiple related questions on each page. In the progression to a vertical prototype the underlying functionality was developed to include dynamic tailoring of questions, resulting in only questions/sections which were relevant being displayed to participants, thus providing the potential to shorten the questionnaire. Question types were also converted to one touch responses where possible in accordance with the touch screen design.

OHA Charting

The functionality for patient examinations was integrated into the vertical prototype of the OHA, providing an opportunity to evaluate different methods for charting.

Three formats were presented to the fields sites for evaluation:

1. Direct Manipulation

Simulating traditional charting methods the dentist was presented with the teeth outline, to record fillings, missing teeth, crowns etc. Using direct manipulation a selection was made from the charting options followed by selecting the tooth in question (Figure 3.14).

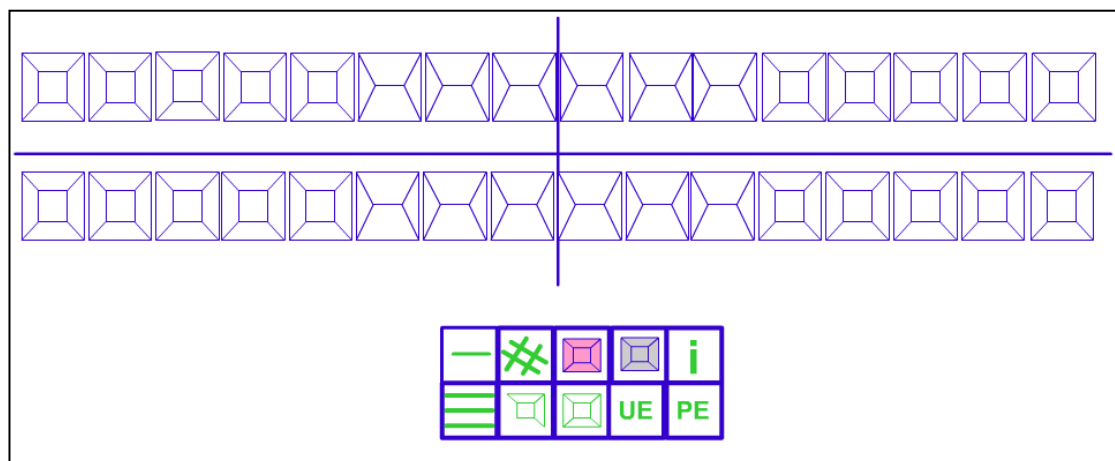


Figure 3.14 Chart Direct Manipulation Interface

2. Design Metaphor

Capitalising on the capabilities provided by the touch screen interface and again focusing on existing charting methodologies the second option allowed dentists to draw directly onto the chart using a touchscreen pen (Figure 3.15).

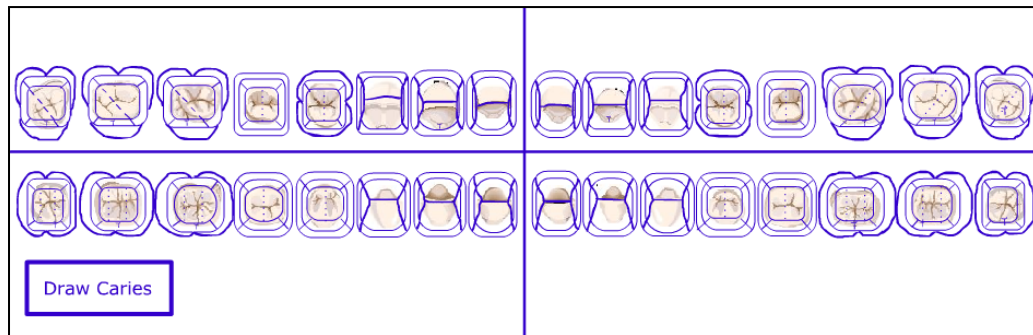


Figure 3.15 Chart Design Metaphor Interface

3. Menu Driven Interaction

The third option presented the dentist with a series of menu options (Figure 3.16) from which they selected options to record the examination.



Figure 3.16 Chart Menu Driven Interface

From user evaluations the preferred method for charting was option 1, found to be “*intuitive*” and “*quick to use*” but most importantly providing a standardised set of recognised symbols. Users found that option 2 did not provide the level of fine control required to accurately draw detailed examination results. Option 3 was found to be too time consuming, indirectly navigating through menus and making selections.

OHA Algorithms

It was also in the vertical prototyping phase that the underlying rules/logic and decision trees were integrated. Examples of such rules included:

Hiding teeth - Charting

If the dentist had selected missing teeth on the initial charts these teeth were hidden on all subsequent charts.

Rash Algorithm – Extra-Oral Examination

Based on the Rash Diagnosis List as defined by eMedicine Health (<https://www.emedicinehealth.com/etools/rash-diagnosis-list-creator.asp>) the rules were built in to aid the dentist in making a clinical rash diagnosis (Figure 3.17).

The screenshot shows a web-based interface titled "Nicola Stuart - Appearance of Head and Neck". It has a tabbed menu with "Pre-Exam", "Extra-Oral", "General", "Head", "Lymph", and "TMJ". The "Extra-Oral" tab is active, and the "Lymph" sub-tab is selected. The main content area is titled "Skin Rash Identifier" and contains three questions with radio button options:

- 1. Is it fluid-filled or solid?
 - ☐ Fluid-filled (e.g. blister)
 - ☐ Solid
- 2. What colour is it?
 - ☐ Red
 - ☐ Skin-colour
 - ☐ White
 - ☐ Brown-black
 - ☐ Yellow
- 3. Is it scaling?
 - ☐ Yes
 - ☐ No

There is a yellow callout box on the right that says: "If you are unsure what a rash is this helps to diagnose it, answer the questions, then click ok." At the bottom right is an "Ok" button. Below the main form is a text area with the label "Any extra details can be entered here." On the left side, there is a vertical list of text: "This", "wo", "les", "fac", "vie", "lac", "ras", "gen". Below this list is a yellow callout box that says: "To a four area gene desc".

Figure 3.17 Clinical Rash Diagnosis Interface

Risk Assessment Algorithm

Based on the full OHA assessment including the patient questionnaire potential risk areas were identified and highlighted to the dentist who would then decide on how best to proceed. A traffic light metaphor was adopted with red indicating risk and green no risk (Figure 3.18).

	Yes	No
Medical History		
- Conditions that potentially put the patient's general health at increased risk if they should develop dental disease/infection	<input checked="" type="radio"/>	<input type="radio"/>
- Conditions that increase a patient's risk of developing dental disease	<input checked="" type="radio"/>	<input type="radio"/>
- Conditions that may complicate the provision of dental treatment or may compromise the patient's ability to maintain their oral health	<input type="radio"/>	<input checked="" type="radio"/>
Social History		
- High caries in mother and siblings	<input type="radio"/>	<input checked="" type="radio"/>
- Tobacco use	<input type="radio"/>	<input checked="" type="radio"/>
- High/excessive alcohol use	<input type="radio"/>	<input checked="" type="radio"/>
- Family history of chronic or aggressive (early onset/juvenile) periodontitis	<input type="radio"/>	<input checked="" type="radio"/>
Dietary Habits		
- High sugar intake	<input checked="" type="radio"/>	<input type="radio"/>
Exposure to Fluoride		
- Use of Fluoride toothpaste	<input type="radio"/>	<input checked="" type="radio"/>
- Other sources of fluoride e.g. live in a water fluoridated area	<input type="radio"/>	<input checked="" type="radio"/>

Figure 3.18 Risk Identification Interface

Calculating Recall Interval

The patients recall schedule was determined by combining the NICE recommendations, the risks identified through the OHA, the dentist's clinical judgement and a shared decision making process involving the dentist and patient (Figure 3.19).

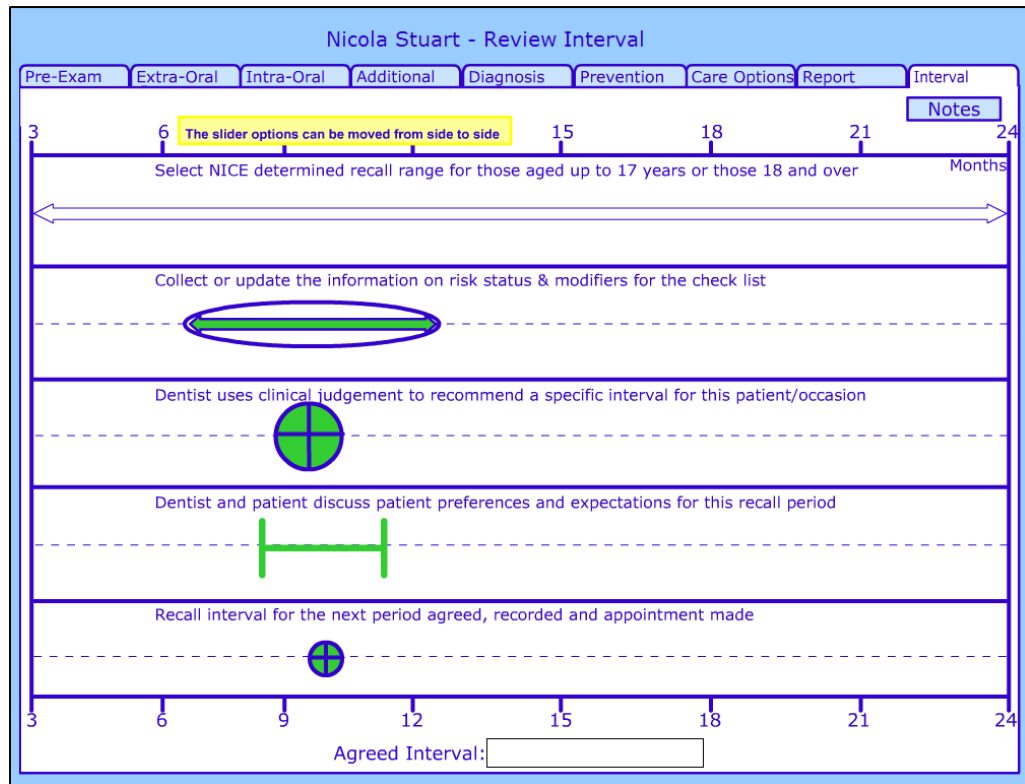


Figure 3.19 Recall Shared Decision Interface

3.3.4.3. Implementation

The final patient prototype questionnaire captured the three main sections of the patient requirements medical, dental and social histories (Figure 3.20) as defined by the Clinical Advisory Group. Only relevant questions were presented to patients thus minimising the user load by the removal of redundant or inappropriate questions.

Clinical Care Pathways
Social History (1 of 2) Next

1. Have you been shown by a dental professional how to clean your teeth? Yes ▼

2. Do you wear a denture? ☒ Yes ☐ No

2a. How do you clean your denture? Soak it in a denture cleaning product ▼

2b. How many times a day do you clean your denture? Twice or more a day ▼

2c. When the denture is removed do you have any remaining natural teeth? ☒ Yes ☐ No

3. Which of the following do you use on a regular basis?

- ☒ Toothpaste
- ☐ Mouthwash
- ☒ Fluoride tablets or drops
- ☐ Dental floss or any other oral health aid
- ☐ Sugar free chewing gum

3a. Do you use a fluoride toothpaste? ☐ Yes ☒ No

3b. How many times a day do you clean your teeth? Twice or more a day ▼

3c. Please specify type of tooth brush you use:

- ☒ Manual
- ☐ Electric
- ☐ Other

3d. Do you rinse your mouth with water after brushing? ☐ Yes ☒ No

Figure 3.20 Example Patient Questionnaire Page

Piloting of the patient questionnaire was carried out at Dundee Dental Hospital by 11 participants (4 male, 7 female). Results were very positive and patients' suggestions for improvements were incorporated into the final prototype. Eight of ten participants preferred the computerised version of the questionnaire finding it easy to use and understand.

Oral Health Assessment

Both the full and minimised fast track OHA were developed. A variance record was implemented for cases which resulted in any deviation from the main pathway.

The sections of the OHA were separated adopting a tabular folder metaphor. The responses captured through the patient questionnaire passed directly into the initial review stage of the OHA (Pre-Exam). Answers which indicated potential risks were highlighted in red text, non-risks in blue text and answers which the dentist had

edited were shown in green text. The Extra-Oral Examination focused on general appearance, the external head and neck area, lymph nodes (Figure 3.21) and jaw movement.

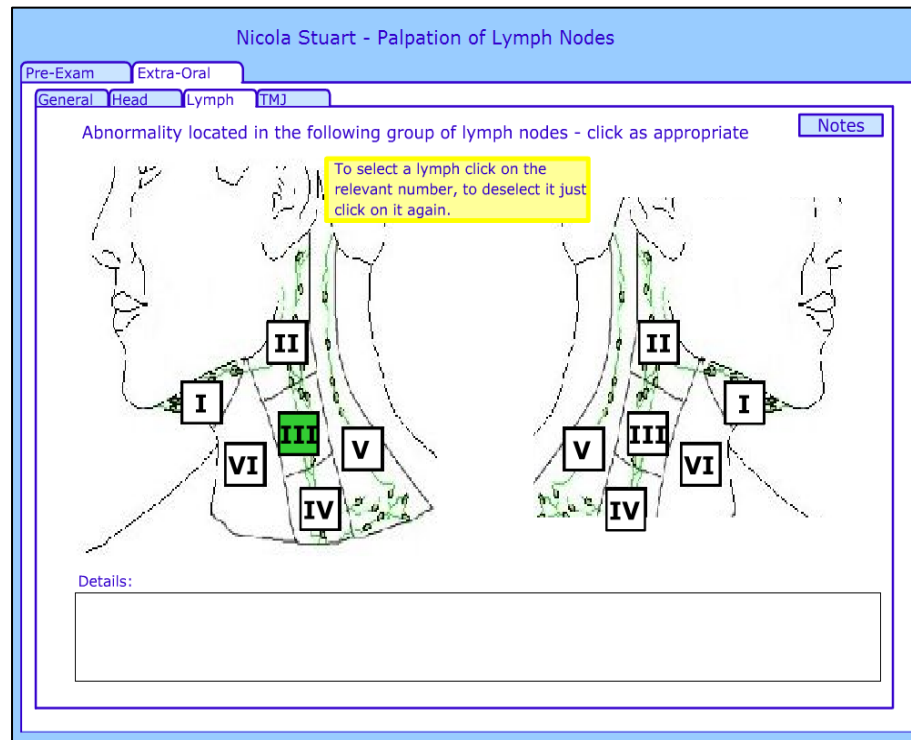


Figure 3.21 Extra Oral Examination – Lymph Nodes

Following on through the pathway the next stage was the Intra-Oral section, consisting of highly detailed examinations and charting including identification of hygiene issues; bleeding; documenting denture designs (Figure 3.22); soft tissue lesions (Figure 3.23) and plaque locations.

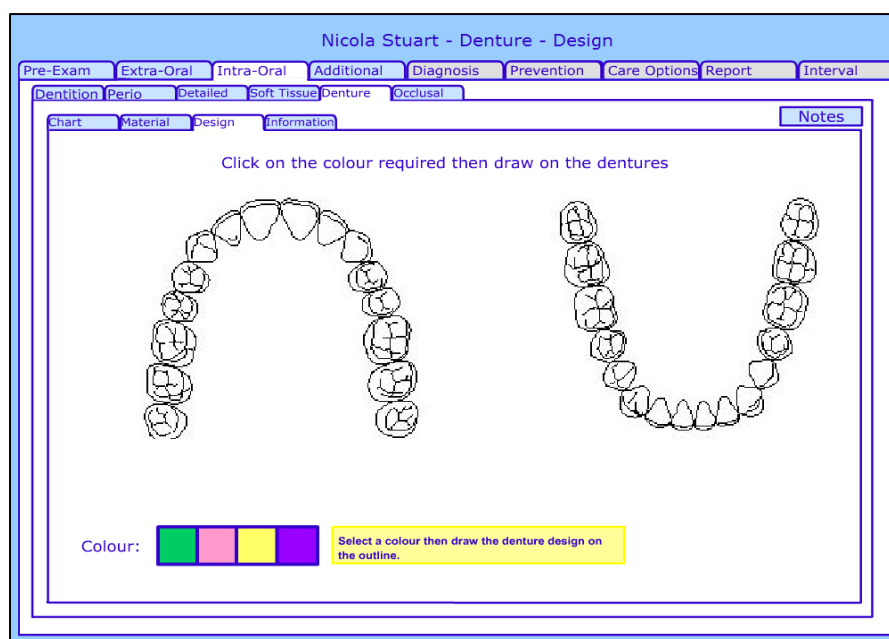


Figure 3.22 Denture Design

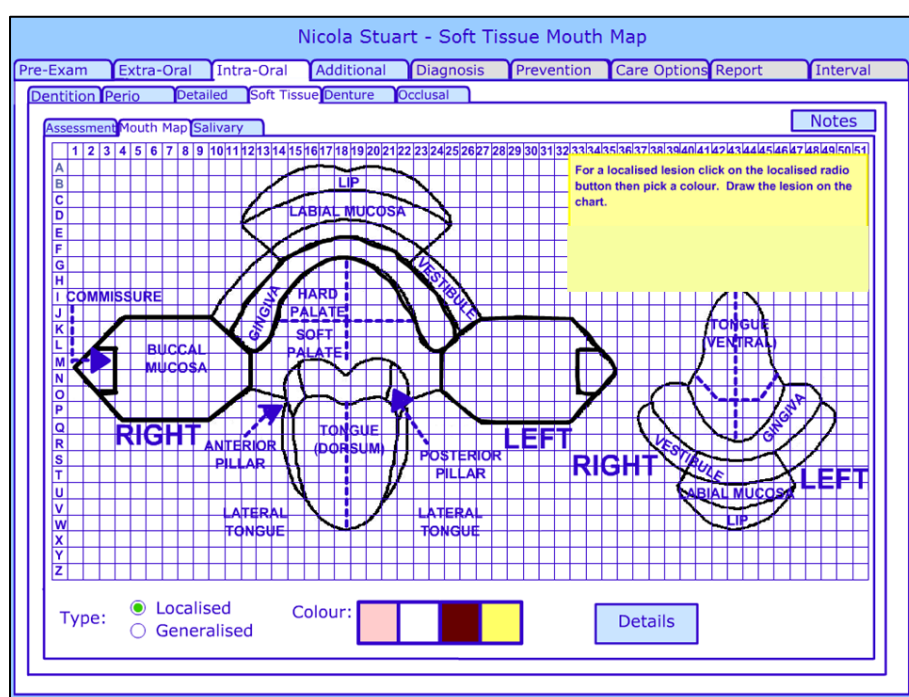


Figure 3.23 Soft Tissue Lesions

The additional section captured supplementary test results such as x-rays and biopsies. As mentioned the diagnosis section presented the collated risk assessment information from each section into one report before highlighting possible prevention service options and information material such as smoking cessation and

healthy living advice. Based on the previous sections the OHA algorithms determined future Care Options i.e. subsequent pathways for the patients requiring surgery, prevention or restorative care. The initial order of care is proposed by the OHA to be used as a discussion platform between the dentists and patients. The final two sections Report and Interval complete the pathway by documenting a summary of the full OHA results and indicating the patient review period.

In addition to the field site evaluations the final OHA prototype was also evaluated by a focus group of 10 dentists from the Dundee Dental School held over 2 one-hour sessions. Although the participants voiced reservations relating to the new methods of care specifically citing time restrictions as the main issue they found the software enjoyable and easy to use.

3.3.5. Recommendations for Further Work

Areas for consideration based on comments from the fields sites and focus groups highlighted the following suggestions:

- Link the software with the current dental systems containing appointments/patient contact information with the aim of removing duplication of effort.
- Change the colours used for responses in the patient questionnaire review. Red, blue and green cause difficulties for colour-blind users
- Addition of an ethnicity question
- Add mental health questions

3.3.6. Summary

The project brief was to develop a web-based patient questionnaire and oral health assessment prototype in collaboration with a clinical advisory group and remote field sites. The software development captured the functionality defined by the paper-based algorithms forming an OHA concept model. Adopting a divide and conquer approach the software development included five iterations of prototypes over the development lifecycle lasting a year and a half. Each iteration was evaluated remotely by the field sites through a web-based bulletin board, culminating in a final evaluation in the form of focus groups by both patients and dentists. The prototype highlighted the components of the OHA in a dynamic form, allowing information to be collated and transferred where appropriate to various stages of the assessment. The final prototype provided the blueprint for the ultimate OHA IT format to be used in discussion with commercial companies developing the live system.

3.4. Case Study 3: Decision Aids for Depression (DECADE)

3.4.1. Background

The aim of this two year, three phase study funded by the National Institute for Health Research (NIHR) was to produce and pilot test a decision aid for patients and GPs in the management of mild/moderate depression in primary care. The research questions it was seeking to address were:

- How is treatment of mild/moderate depression in primary care currently agreed between patients and GPs?

- What are the views of patients and GPs regarding a decision aid to help them select a treatment for depression? What is the optimum content and design of such a decision aid?
- What are the issues to be considered in designing a trial to assess the effects of such a decision aid on decision quality, treatment choice and clinical outcomes?

This project involved a multidisciplinary group from the School of Computing at the University of Dundee and the Department of Primary Care at the University of Bristol.

3.4.2. Study Design

The first phase of the study focused on capturing the intervention content through interviews with patients recently diagnosed/treated with mild/moderate depression, GPs and adopting the most recent evidence base of effectiveness of different treatment options. The second phase transformed the static content into an information website and decision aid before evaluating the resources with focus groups of GPs and patients. The final phase consisted of a four month feasibility study where participants were randomised to either usual care with questionnaires, information website with questionnaires or the full combination of website, questionnaires and decision aid.

3.4.3. Study Results

Unlike the previous two case studies the author and software development team were only involved in the 2nd developmental phase of the project in the creation of the software outcomes. The development included the creation of web-based questionnaires, an information website and a decision aid.

3.4.4. Intervention Development

The software development phase took place between December 2007 and September 2008 culminating in the creation of:

Web-based Patient Questionnaires: the patients interacted with the software over a period of four months, during which at relevant time points, they would be asked to complete 4 online questionnaires. The questionnaires were completed by all arms of the feasibility study.

Information Website: containing information for patients newly diagnosed with mild/moderate depression on topics such as What is depression?; the impact of depression; choosing a treatment for depression; patient experience stories and useful links. This section was available to all participants with the exclusion of the control group.

Decision Aid: relating to preferred treatment options which included supportive care; guided self-help; antidepressant medication and complementary therapy. The aim of the decision aid was also to promote shared decision making between patients and GPs. Only the intervention group of the feasibility study received this tool.

3.4.4.1. Requirements Gathering & Design

Prior to this project the author had gained experience in developing healthcare resources as part of a multi-disciplinary team from six projects including the previous two case studies. Although the healthcare topics in each project were different the software requirements were very similar, thus processes and methodologies adopted were the same with the main focus on early and continuous user involvement and rapid prototyping.

The initial requirements gathering, background research and prototyping phases of this project followed a similar implementation to that discussed in the two previous case studies presented. Prosdex (Evans *et al*, 2007) was identified as a tool providing similar functionality in the field of prostate cancer testing. Horizontal prototypes were developed in the form of a framework with section navigation which was then evaluated to demonstrate the flow through the system.

However at this stage the software development followed an alternative implementation. Previous experience found that a significant period of time is spent by the software developer adding content, formatting and making changes to textual content based on project team and user feedback. These updates do not require someone with software development skills provided the functionality is in place for non-programmers to facilitate these changes. Once the framework for the information website was confirmed page placeholders were created to allow the project researcher to upload page content using an online XML based solution, permitting the software developer to focus the programming aspects primarily the

development of the questionnaires and underlying decision aid algorithms. Another area highlighted which could lead to the research team in gaining more control of the software development was in extraction of the project data. Typically in this type of multidisciplinary project the software development team would extract the project data either for interim analysis or on project completion to be analysed by the research team/statistician. To remove this step in this project secure access was provided to a website which enabled researchers to directly download the data.

3.4.4.2. Implementation

Following the prototyping evaluation the software output for this project consisted of web-based patient questionnaires, an information website and decision aid, all developed using Flash MX with underling PHP and MYSQL database.

The patient questionnaire consisted of four 12 page questionnaires collecting treatment preferences (Figure 3.23); views on depression; current state of health and level of GP support.

Questionnaire 1 P 2/12

2. If you had to decide right now, which treatment do you think you would most prefer to have?

- ☐ Supportive care (possibly making some personal changes but no formal treatment and review of your symptoms in due course)
- ☐ Guided self-help (working through materials such as books, audiotapes, DVDs or computer programs)
- ☐ Talking therapy (for example, counselling, cognitive behavioural therapy, psychodynamic therapy)
- ☐ Antidepressant medication (taking tablets, such as fluoxetine)
- ☐ Combined treatment (Guided self-help or Talking therapy AND Antidepressant medication)
- ☐ Other (for example, Complementary therapies - please enter)

Any reasons why you would like this type of treatment?

Back Next

Figure 3.23 DECADE Example Patient Questionnaire

The information website was viewable by two of the feasibility study arms excluding those in the usual care group. In this tool the navigation structure framework (Figure 3.24) was created by the author (software developer) with the content was provided by the project researcher.

1. What is depression?

- Overview
- ⊖ How do people experience depression?
 - In this section...
 - Personal accounts of depression
 - * Symptoms of depression *
 - Thoughts of self-harm and suicide
 - A historical perspective
- ⊖ How do doctors diagnose depression?
 - In this section...
 - * The process of diagnosis *
 - How do doctors classify depression?
 - Questions used to diagnose
 - Special types of depression
 - Depression and other illnesses
 - How common is depression?
 - * Possible causes of depression *
 - * Can depression be cured? *

2. The impact of depression

3. Choosing a treatment for depression

4. Useful links

Figure 3.24 Navigation/Section Framework

The information was broken down and grouped into 4 main sections with sub sections. Each section included personal reflections (Figure 3.25) from people

suffering from depression, their families or from medical staff; frequently asked questions and links to further information.

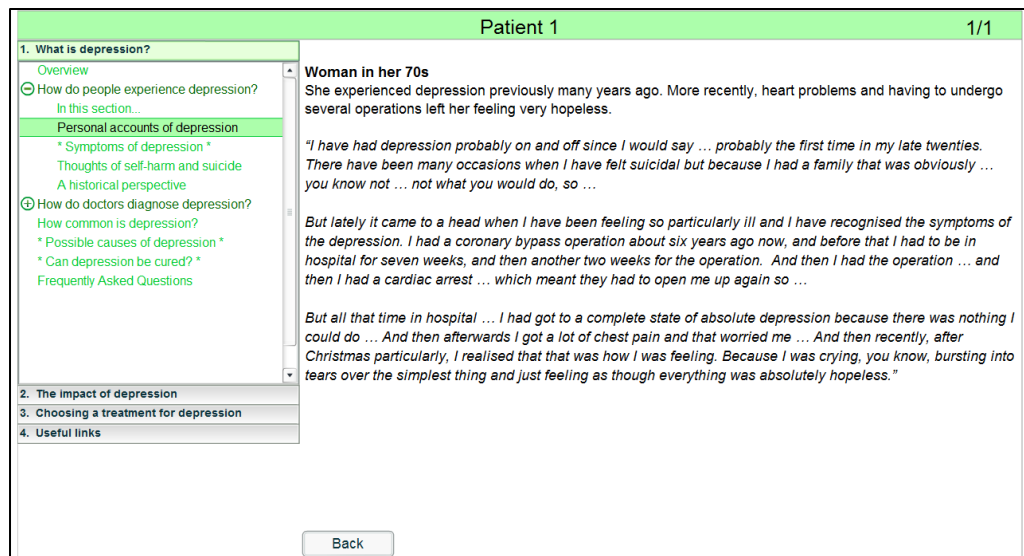


Figure 3.25 Patient Experience

An accordion expand/contract metaphor was adopted to access relevant information. Information was provided regarding possible treatment options for depression to be used in discussions between the patient and GP in the subsequent treatment decision making process.

The decision aid was only available to those in the intervention arm and the decision aid only became active after completion of questionnaire 1. The participants were presented with 17 statements (Figure 3.26) such as “*I would like to take responsibility for where and when I have my treatment*” or “*I would take medication every day for several months*”, which they rated on a five point Likert scale ranging from red (strongly disagree) to green (strongly agree).

Figure 3.26 DECADE rating mechanism

An underlying algorithm calculated scores for the following treatment options: supportive care; guided self-help; NHS Counselling; private cognitive behavioural therapy (CBT); other private psychotherapy; antidepressant medication and complementary therapy. On completion of all 17 statements the participant was presented with a results bar chart, where the treatment option with the highest score was the preferred treatment option (Figure 3.27).

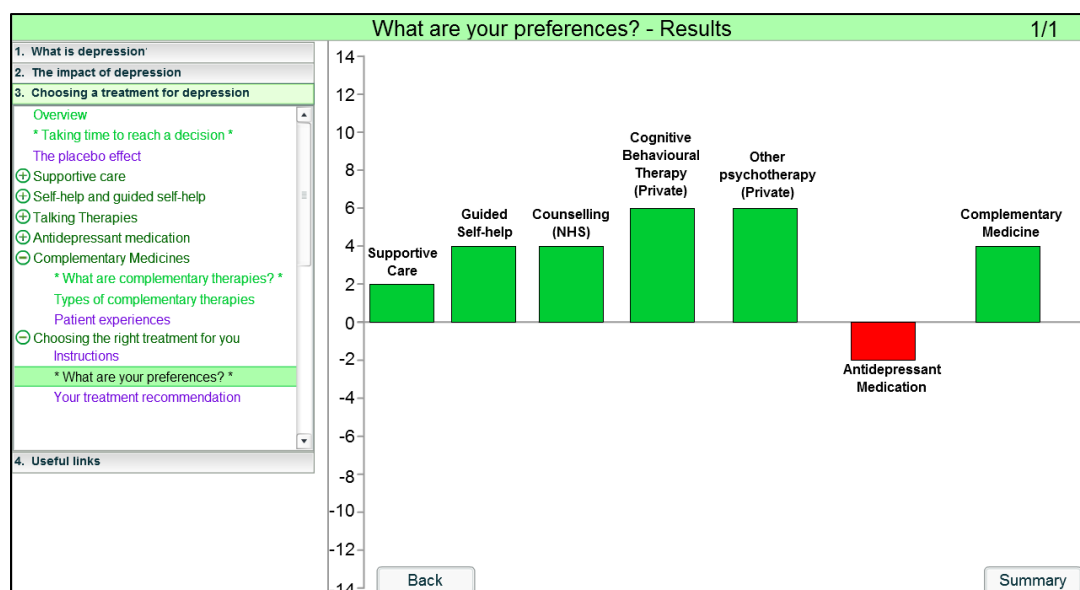


Figure 3.27 DECADE results graph for treatment options

A summary of all positive treatment preferences (Figure 3.28) was also presented alongside the statements which the participant agreed or strongly agreed with. This information could then be printed for discussion with their GP.

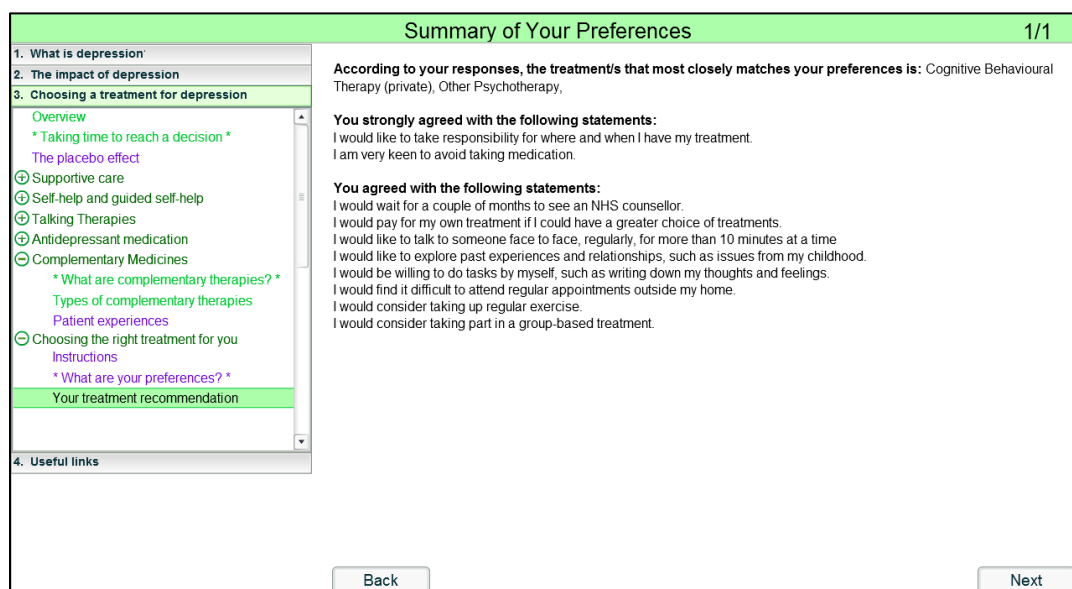


Figure 3.28 DECADE Textual treatment preference

The software development team had no involvement in the Phase 3 feasibility study.

3.4.5. Summary

Five years' experience developing similar healthcare interventions with a focus on providing patients with condition specific information and promoting shared decision making, prompted the author to take a change in direction in the development of the software for this project, through the investigation of empowering the research team. User-centred design and rapid prototyping still formed the central theme in the software development however providing functionality for the researchers to contribute to the development of the content without the requirement to learn any software development skills was also a major motivation. Patient questionnaires, a framework for an information website and a decision analysis tool were developed by the author in collaboration with the research team, GPs and patient representatives, but the information content was developed, formatted and updated by the project researchers. The research team also had full control over data extraction through access to a secure website. This additional functionality was identified to try and relieve the reliance of the research team on the software developer. The researchers gained control over elements previously deemed to be 'programming tasks' thereby enabling the software developer to focus more effort on those tasks which required programming, including the underlying algorithms supporting the questionnaire logic and decision aid calculations. The author's involvement concluded in the phase 2 developmental phase of the project with the software tools ready for use in the phase 3 feasibility study.

3.5. Case Study Discussion

Three distinct healthcare focused case studies were presented in this chapter in the areas of obstetrics, dentistry and mental health. During the period 2003-2008 the author was also involved in the development of similar software in the fields of oncology, hypertension and primary care. All the studies shared a common goal of promoting shared decision making between patients and their medical team and increasing knowledge by providing relevant information in a usable and accessible format.

Project teams consisted of multidisciplinary stakeholders with the involvement of user representatives in the form of the general public and healthcare professionals. The researchers involved in the projects had little or no previous software development expertise. The development lifecycle for each project focused on early and continuous user involvement, adopted a rapid prototyping methodology and emphasised the importance of evaluation.

Additional similarities were also highlighted through the development of the software which identified commonalities in the structure, flow and presentation of information. It was also noted that any changes to the software required additional funding and heavily relied on the involvement and availability of a professional software developer.

On project completion the software created was often redundant because it was developed as part of a feasibility or pilot study, or further development ceased due to changes in funding or healthcare hot topics. Out of the seven projects discussed only the software developed in Case Study 1 is still in existence, accessible through Health Talk Online. This redundancy results in software and knowledge residing with the software developer for repurposing in other projects but cannot be applied by the research team in future endeavours, without further involvement of a professional developer. Case Study 3 took steps to bridge this gap between the research teams skill set and a professional software developer without a cost to the project in terms of time or quality.

The recognition of the similarities led to the identification of the following three questions:

1. What are the requirements of a typical healthcare Internet Intervention?
2. What are the common components utilised in an Internet Intervention?
3. What is the typical profile of researchers wishing to create Internet Interventions?

If the answers to these sub questions could be defined and common components described, is it possible to identify or create such a tool which researchers could exploit in the development of Internet Interventions. Would such a tool result in a power shift back to the researcher reducing the current dependence on professional software developers?

3.6. Internet Intervention Requirements

Although Case Study 3 allowed the researcher to alter the content of the information website it did not allow for any change to the design or any alteration to the navigation structure.

Healthcare Internet Interventions have two distinct interactions in the creation of the intervention, by the researcher and by the recipient user who interacts with the intervention. The main functionality required when designing Internet Interventions is therefore the provision of two views, one which provides the toolbox of components required in the design of the intervention and the second view which translates the design into a web-based intervention.

3.6.1. Common Components

The most common components highlighted through the design of the case studies discussed include multimedia; navigation; response capture; logic; storage; user management and logging.

3.6.1.1. Multimedia Component

Utilising a web-based delivery platform provides the opportunity to not only display textual content but also further enhance interventions by incorporating audio, imagery, animation and interactive components (Figure 3.29).

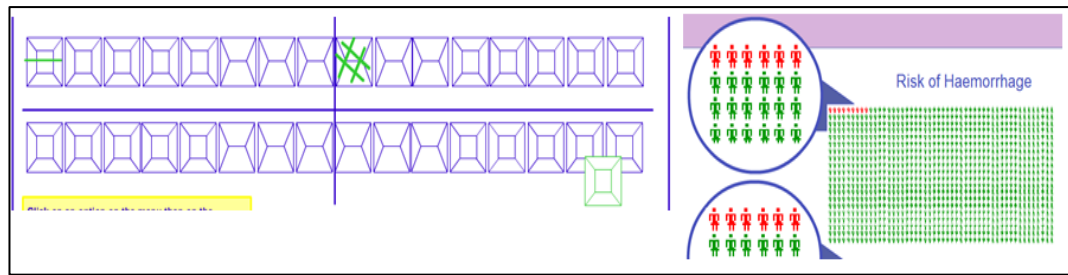


Figure 3.29 Multimedia Functionality Utilised in Case Studies 1 and 2

As mentioned Case Study 1 incorporated images to aid in the understanding of risk information. Animation was utilised in the provision of user instruction. Case Study 2 relied heavily on images and animation in the charting and examination sections.

3.6.1.2. Navigation

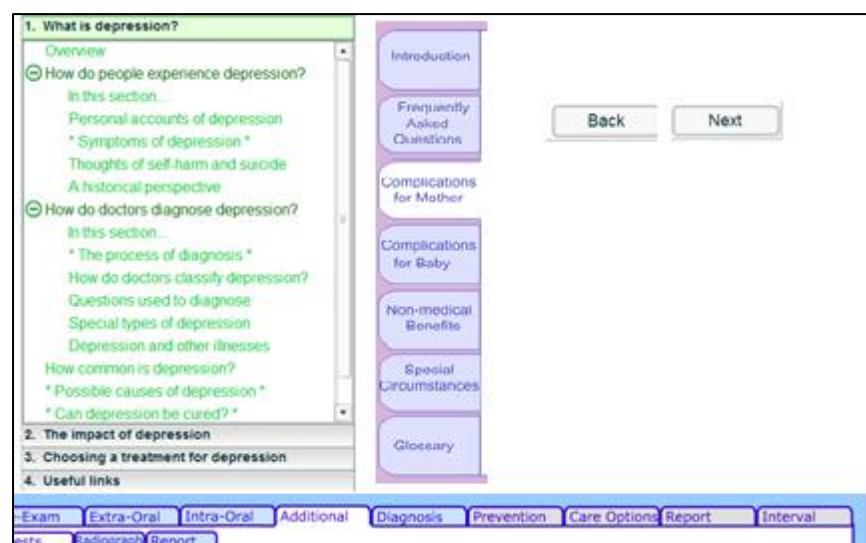


Figure 3.30 Navigation Menus and Buttons Adopted in all Three Case Studies

Menus and buttons control the flow between pages and sections of an intervention (Figure 3.30). In all three case studies content was appropriately grouped with access through a menu system. Buttons were also employed to move back forth between pages.

3.6.1.3. Response Capture

Each of the interventions required user responses to be captured via questionnaires, rating scales or selections. Different types of data entry fields included free text collection, Likert scales, radio buttons for mutually exclusive responses, check boxes for multiple selection responses, drop-down menus for responses that have a large number of possible options and simple button selections (Figure 3.31).

Possible Health Complications

Complications For Mother	Complications For Baby
1. Avoid A Future Health	1. Baby In Future Health
2. Blood Clot	2. Breathing Difficulties
3. Haemorrhage	3. Baby In Poor Condition
4. Infection	4. Brain Injury
5. Hypertension	5. Death of Baby
6. Incontinence	
7. Severe Perineal Damage	
8. Surgical Damage	
9. Death of Mother	

1. Please tell us a bit about yourself. All your answers will be treated in strict confidence.

a. At the moment, do you think you have depression?

☐ Yes
☐ No
☐ Not sure

b. Have you experienced depression previously?

☐ Yes
☐ No

c. Is this the first time you have talked to a doctor about depression?

☐ Yes
☐ No

d. How well do you know the doctor you saw about depression?

☐ Very well
☐ A little bit
☐ Not at all

e. Which of the following best describes you?

☐ I like to rely on my doctor to tell me what I need to know about my health
☐ I like to study leaflets or other sources of information provided by my surgery and GP to find out more about my health
☐ I like to find out health information by myself (for example, from friends, books or the internet) as well as study information provided

Study Models ☒ Upper Impression ☒ Lower Impression ☐ Notes

Figure 3.31 Response Capture Component Types

3.6.1.4. Logic

Logic is necessary to perform any calculations required in an intervention, such as in a decision aid to calculate the preferred method of treatment based on participant input and a decision tree. Logic is also required to dynamically tailor an intervention based on participant's responses, to show and hide sections depending on which stage in the study they are currently in and in the randomisation of participants to different study arms. Logic was required in all three case studies to: calculate scores, recall intervals and to make logical decisions as to when menu options should be displayed or hidden (Figure 3.32).

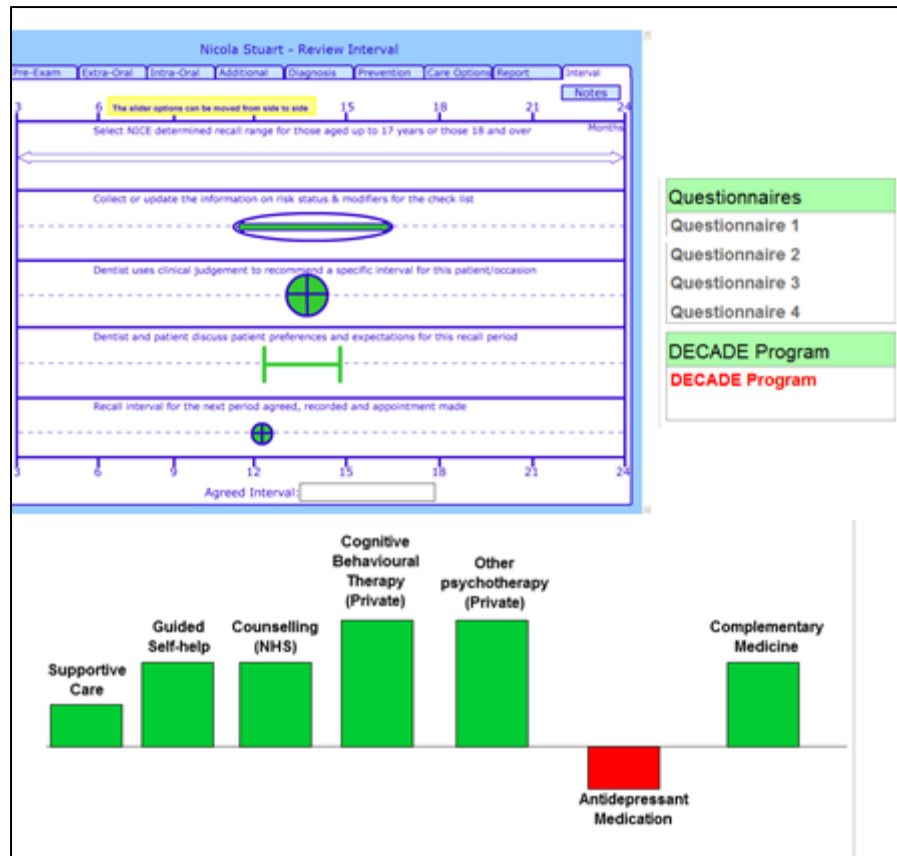


Figure 3.32 Case Study Examples of Logic Requirements

3.6.1.5. Storage

Internet Interventions require the participants' responses to be stored for later analysis. Typically this storage would be in an underlying database. In the three case studies discussed participant responses were stored in a MYSQL database.

3.6.1.6. User Management

The figure displays three separate login screens. The top-left screen, titled "The DiAMOND Study - Login", has a light purple border and contains an "ID Number:" label followed by five empty square input boxes and a blue "Ok" button. The top-right screen, titled "Login:", has a light green border and includes "Username:" and "Password:" labels with text input boxes, and a "Login" button. The bottom screen, titled "Dentist Login", has a light blue border and contains two prompts: "Please enter your first name:" and "Please enter the password:", each followed by a text input box, and a blue "Ok" button.

Figure 3.33 Case Study User Login Interfaces

Typically Internet Interventions would require login access to view information resources or to interact with the decision aids. User accounts are particularly significant in longitudinal studies requiring multiple accesses to the system over time. User accounts were required in all three case studies (Figure 3.33).

3.6.1.7. Logging

Logging frequency of use, pages visited, page flows, duration of access and time of access are all valuable when monitoring the usage of an intervention. This information can be applied to highlight problem areas e.g. if participants are having difficulties with a particular question. They are also useful when identifying the most popular sections, or conversely which pages are viewed for the least amount of time.

3.6.2. User profile

In the studies discussed each group consisted of members from varying backgrounds including academic researchers, medical professionals, statisticians, user representatives, designers and software developers. In these types of research studies generally the principle investigator is either an academic researcher or a research active medical professional, larger budget projects also have an additional layer of research assistants. Occasionally members of the group have prior software development experience but more often they will not. Their main focus is research which consumes a large proportion of their time, they do not have the time or effort to learn how to program.

The following characteristics were identified as the typical requesters of Internet Intervention software resources.

User Criteria	User Characteristics
Age	Range from 18 to 80
Sex	Both male and female
Limitations	Full spectrum no limitation - cognitive or physical impairments
Educational background	Educated to higher education qualifications
Computer/IT use	Range of possible experience levels from little or no prior experience to professional software developer
Motivation	Research, improving and supporting healthcare through interventions
Attitude	Priority is research not software development
Frequency of Development	Intense usage on an infrequent basis

Table 3.1 Characteristics of Internet Intervention Researchers

3.7. Summary

Three case studies were presented in this chapter describing the process of developing Internet Interventions by a professional software developer as part of a

multidisciplinary team. The development of multiple Internet Interventions focused on user participatory design, rapid prototyping and frequent user evaluation. The heavy reliance of healthcare research teams on professional software developers was identified as a limiting factor, not only through the case studies described but through experience gained in over five years involvement in the development of healthcare Internet Interventions. Although differing in content but not purpose consistent similarities between interventions were recognised such as navigation, data entry and multimedia components. This led to the hypothesis that provided with an appropriate accessible tool requiring no programming skills, healthcare researchers would no longer be reliant on professional software developers and thus be empowered in the creation of healthcare Internet Interventions.

Chapter 4 Development of a Pilot Authoring Tool: Case Study

4.1. Introduction

The previous chapter concluded with the suggestion that provided with an easy to use tool requiring no programming experience; healthcare researchers could create Internet Interventions without reliance on professional software developers. This chapter discusses the lack of such an available tool, followed by describing the development and evaluation of a prototype Internet Intervention authoring tool developed based upon the NEXUS case study, which focused on lowering x-ray referral rates.

4.2. Background

In 2007 the Chief Scientist Office funded a 6 month exploratory pilot study, on which the author was co-investigator entitled - “*A web-based platform to support the development, delivery, modelling and evaluation of complex interventions: Intervention Modelling Experiments (IMEs)*”. This project proposed to develop a first prototype of a web-based IME authoring tool which could be used to develop, model, deliver and test interventions, particularly those based on (but not limited to) psychological theories of behaviour change. The design of the prototype was guided by an existing intervention, the NEXUS IME introduced in Chapter 2. Although the case studies presented in Chapter 3 were not IMEs, IMEs share the same underlying

components required for intervention creation, therefore for the purpose of this thesis are also categorised under the generic term Internet Interventions.

4.3. Study Design

The NEXUS IME was designed to change GP behaviour relating to the inappropriate referral of X-rays. Two questionnaires were sent to GPs pre- and post-intervention, which also included the presentation of simulated encounters of patients suffering back pain. Based on the scenarios GPs were asked to make a clinical diagnosis including whether they would refer the patient for a lumbar X-ray. The GPs were then sent follow up X-ray reports for all referred patients. These reports included one of: audit and feedback, reminder messages both, or neither. Outcome measures included behavioural intention and referral rate in the simulation. The aim of this pilot project was to demonstrate that the functionality provided by this paper-based IME could be replicated on a web-based platform. Again the project team formed a multidisciplinary collaboration with combined strengths in behavioural research; primary care; dental health research; healthcare informatics; software development and user-centred design.

4.4. Study Results

On project completion the NEXUS IME was successfully delivered by the prototype authoring tool. The authoring tool was evaluated in three evaluation settings. Although the prototype was not in a robust state as it only provided the functionality

required to replicate NEXUS it was now possible to see the shape of a system that could be more widely used by healthcare researchers.

4.5. Intervention Development

The project took place between August 2007 and January 2008 concluding with two software deliverables: a prototype Internet Intervention authoring tool and a web-based version of the NEXUS IME. The software development followed the same lifecycle stages as discussed through the case study examples described in Chapter 3, focusing on user-centred design techniques with rapid prototyping with early and continuous user evaluation.

4.5.1. Requirements Gathering

The initial stages in the project involved the identification of the requirements of a tool which could provide the functionality necessary to transform the paper-based NEXUS into a web-based alternative (Table 4.1).

Tool Requirements	Description
Dual-purpose	2 views – design view for researcher to replicate the NEXUS design and the user view to capture GP responses
Multimedia	Textual content, graph functionality for the audit and feedback arm, and images for the reminder arm which represented patient X-rays
Navigation	Button flow between pages
Response Capture	Pre and post intervention questionnaire responses and diagnosis information captured the patient scenarios. Response types required: Free text, radio button, Likert scales
Logic	4 arm - 2 x 2 factorial randomisation Show and hide functionality based on randomisation group. Dynamic tailoring when GP refers for X-ray
User Management	Anonymised linked responses
Logging	This information could not be captured within the paper study.

Table 4.1 Requirements of an authoring tool to create the NEXUS IME

Based on the project requirements and possible cost restraints for this type of generic tool the following ‘*off the shelf*’ solutions were identified but ruled out as ill-fitting solutions (2007):

Questionnaire Creation Tools:

- Bristol Online Survey
- Survey Monkey
- Key Survey
- Survey Said
- Snap
- QDS Design Studio

Website Creation

- Front Page (Discontinued)
- Dreamweaver

Experiment/Application Builders

- Superlab (<http://www.superlab.com/>)
- Axure Software Solutions
- NeoBook Professional Multimedia

These tools were discarded for different reasons (Appendix 1) depending on the services they provided, reasons included lack of interactivity; inflexibility in intervention design; too technical for the user group; not allowing for multiple visits or comparison of data across participants. Front Page; Dreamweaver; Axure Software Solutions and NeoBook Professional appeared to provide the functionality

required however were felt to be too technical for the target user group, particularly in the areas of data storage connection and logic tailoring. Superlab was ruled out as it did not allow for web-based delivery.

Based on the potential multiple, sometimes dispersed stakeholders involved in the development of healthcare Internet Interventions a web-based approach which would allow for multiple user interaction, collaboration, comment and feedback was selected as the most appropriate platform for the design of the authoring tool.

4.5.2. Design

The software output for this project had to deliver two distinct services, providing both an intervention authoring tool and a mechanism for intervention delivery. The development of the authoring tool was the focus of the author, with the intervention delivery mechanism led by another member of the software development team in combination.

The authoring tool was split into 5 sections to allow for pre- and post-intervention and intervention sections and also to include study features set-up such as randomisation and database creation.

4.5.2.1. Prototyping

Based on the short project duration for the production of the prototypes and the level of flexibility required for the development environment, Flash MX was again used to develop the software from horizontal through to full prototype. The initial horizontal

prototype presented users with an accordion metaphor to provide access to the five sections mentioned above (Figure 4.1)

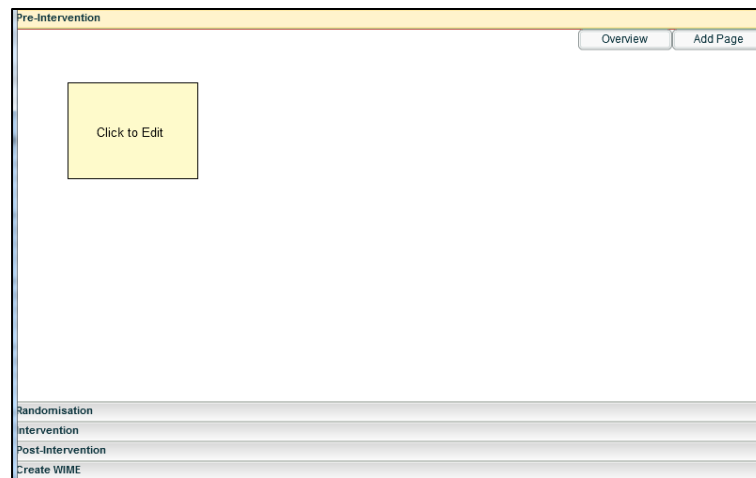


Figure 4.1 Accordion menu options

Each page in the intervention was represented by a note/reminder metaphor where users double click on the page to add content. The page design layer presented a tool box of options which in the case of the NEXUS case study included text, questions, images and graphical components (Figure 4.2).

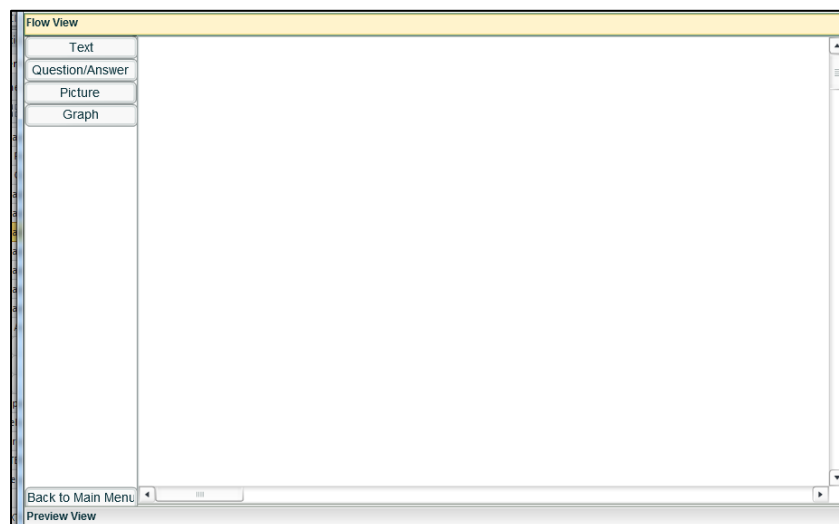


Figure 4.2 Page design interface

The horizontal prototype was evaluated internally within the project group before progressing to the vertical prototype where the following functionality was added:

Page Order: the pages could be reordered by dragging the note pages within the panel, order was determined based on the placement of the top left corner of the page.

Component Functionality: The text component, questions with responses of type text input, radio buttons, check boxes and drop down lists were activated, as well as the functionality to upload images and create basic bar graphs. Content layout was determined by dragging the components around the panel.

Split Design View: The page design screen was split into two windows again adopting the accordion metaphor. The Flow View displayed the component types as blocks whereas the Preview View displayed the page as it would be seen by the participants.

Randomisation: Basic functionality was incorporated to allow for the required 2x2 factorial randomisation which in turn required logic to display only the relevant pages to a user depending on their randomisation group.

Logic: As mentioned one of the main aims of the authoring tool was that no previous programming experience would be required to enter the study logic. To accommodate for this a simple direct manipulation menu selection interface was created (Figure 4.3).

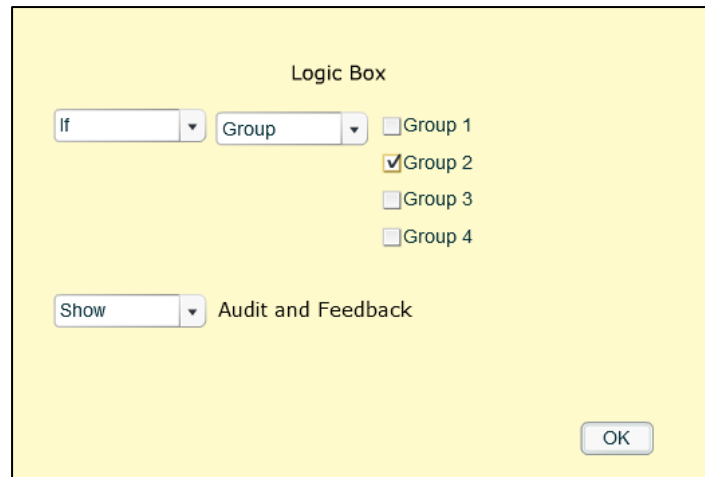


Figure 4.3 Logic interface to show/hide pages

Page Flow: To visualise an overview of the full intervention i.e. the contents of all pages together rather than individually. An Overview View was added which displayed the pages in order including all the page components – questions, answers and images in order of placement on the page.

4.5.3. Implementation

In parallel with the authoring tool prototype the intervention delivery system was also following a rapid prototyping methodology with frequent evaluations by the project team. This system firstly replicated the NEXUS WIME in a static form, the purpose being to determine the definition of the WIME in XML format.

Following the evaluation of both vertical prototypes the authoring tool and delivery mechanism were linked together, where the XML definition of the intervention was provided by the authoring tool to the delivery mechanism. Database creation/connection functionality was incorporated into the authoring tool which created the underlying database tables based on the data entry fields defined on the

pages of the intervention. The database information also formed part of the intervention definition resulting in any user responses entered through the delivery mechanism being stored in the relevant table.

The authoring tool provided the functionality to design the pre- and post-intervention questionnaires including scenarios (Appendix 2), both audit and feedback, and reminder interventions and allowed for the necessary logic required for arm randomisation. The delivery mechanism then parsed the intervention definition into an Internet Intervention accessible to study participants (Figure 4.4).

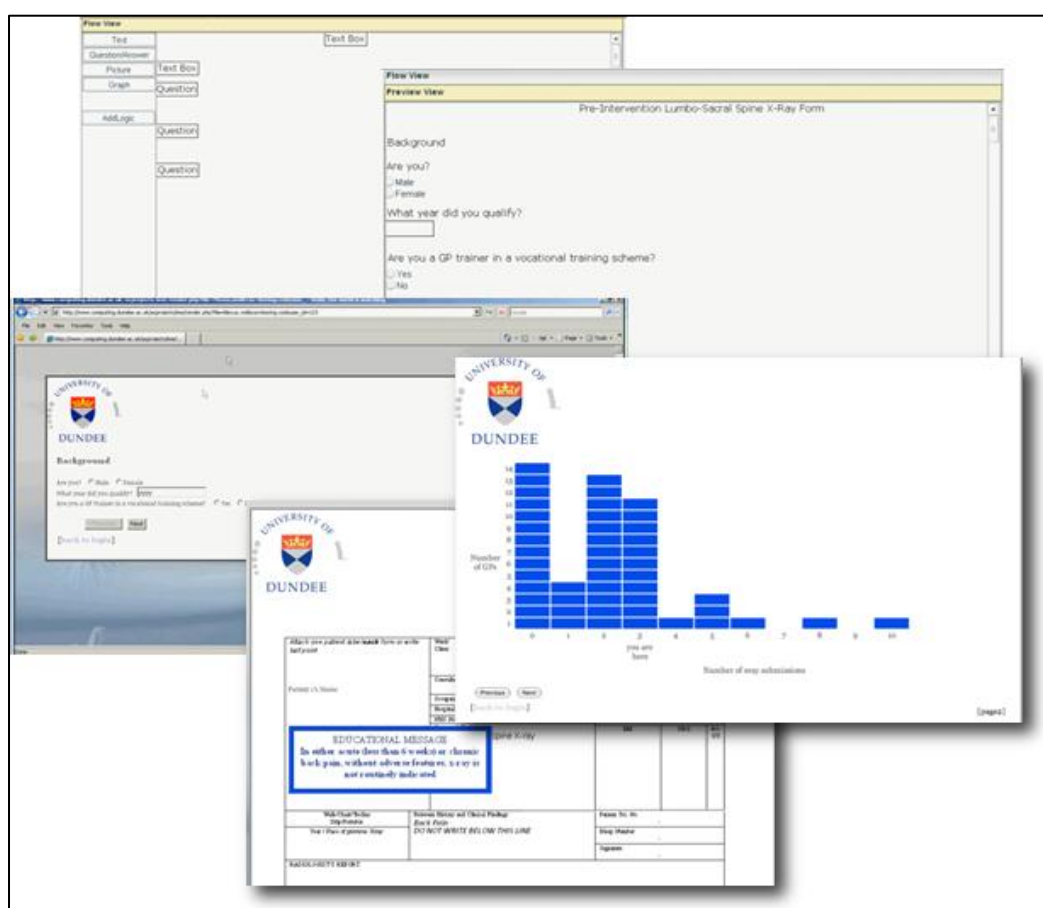


Figure 4.4: NEXUS Design and Delivery Mechanism

4.5.4. Evaluation

The aim of the project was to demonstrate that a web-based version of the NEXUS study could be created through an authoring tool accessed via a web-based delivery platform. The prototype system was evaluated iteratively over the six month project duration by team members, whose multidisciplinary backgrounds are typical of users of such a tool. The final prototype system was also evaluated using three different approaches:

4.5.4.1. Heuristic Evaluation

Heuristic evaluations were carried out by three usability experts from the School of Computing, University of Dundee who were external to the project. Strengths and weaknesses of the prototype interface were highlighted which led to a number of recommendations summarised in Table 4.2:

Strengths	Weaknesses	Recommendations
The system is easy to use and questionnaires and interventions can be built without difficulty	Default positioning of components can lead to new components being obscured by existing ones	Question types need better names
The system performs in a consistent manner	Dragging components around in the Flow view can be fiddly	New components need to be positioned on screen so that they are not obscured by existing components
Navigation is great, slider subsections good	Difficult to see how much room a component will occupy without going to the Preview	The system needs to have a cut & paste facility and to store templates
Nice use of screen real-estate.	Some of the terminology is likely to be unfamiliar to users	A grid should be added to the Development Environment to make positioning of components easier

Table 4.2 Heuristic Evaluation Feedback Summary

4.5.4.2. *User Feedback Session*

A feedback session was held with participants from the Community Health Sciences Group, University of Dundee, again a group who represented typical users. The session generated a great deal of discussion and comment (Table 4.3). The session commenced with a demonstration of the software prior to open discussion and feedback.

Strengths	Weaknesses	General comments
Flexible and powerful survey authoring tool	Survey output needs to look more professional	The system depends critically on the quality of the scenarios
Offers the potential for multiple studies at low cost	It should be easier to re-use previous question/materials. Needs cut & paste.	Video-based scenarios will probably be a big improvement on text-based
The system could also be used to investigate changing patient behaviour	No possibility of saving a form so that user can return to it later	The user interface needs to be simple enough for infrequent users to not have to relearn the system each time
Could also be used to deliver stated-choice studies, conjoint analysis or factorial surveys	Doesn't have a flexible randomisation system	A web-based system will only be used by Internet-savvy users. Is this enough?

Table 4.3 User Feedback Session Summary

4.5.4.3. *Formative Evaluation*

The software developed in the project was still very much a '*work in progress*' and as mentioned only provided the functionality required to replicate the NEXUS Study, therefore a formative evaluation, which would be used to inform the next phase of development, was deemed to be most appropriate. The Aberdeen Health Services Unit Psychology Group were identified as a resource with a potential target user group. Twenty psychologists were provided with the paper equivalent of the NEXUS pre-intervention section of the NEXUS study and a ten minute instruction video of the intervention authoring tool before being asked, in groups of two, to replicate the pre-intervention questionnaire section of the study using the authoring tool prototype. The feedback was positive.

A subset of comments includes:

Strengths	Weaknesses	General comments
After about 5 minutes of playing around it's easy enough	Would prefer to have it all in preview as it's hard to work out spacing	Tremendous scope, very participant/data entry friendly, powerful and flexible
Generates format of questions at press of a button	Couldn't change fonts etc.	Interesting and very flexible for the purpose of Internet based experiments
Brilliant to avoid coding	New items appear one on top of the other	More complex randomisation algorithms need to be supported
Question logic	Label descriptors need to be more informative, e.g. what is a radio button?	Easier to use and neater to use than current tools

Table 4.4 Formative Evaluation Feedback Summary

4.6. Recommendations

A combined thematic analysis of all three evaluation formats identified the following common recommendations for improvements to the authoring tool and delivery mechanism:

4.6.1. Design/Preview View

Splitting the design and preview views led to difficulty placing the components on the screen. A more appropriate solution would combine both views and provide the functionality to toggle between the two as required. This could be further enhanced by providing a grid or coordinates to easily align components.

4.6.2. Formatting

Standard text formatting capabilities such as the ability to change colours, font sizes and styles together with the inclusion of style sheets would lead to more professional looking interventions.

4.6.3. Randomisation

The randomisation criteria within the prototype was defined by the NEXUS Study requirements, future use of the tool would require the facility for alternative randomisation algorithms.

4.6.4. Terminology

The labelling adopted in the prototype was found to be too technical, and should be altered through further user involvement to create a more user-friendly interface, e.g. in the case of the toolbox components where the question response types are labelled radio, check or combo.

4.7. Summary

Based on a '*real world*' case study this chapter described the development of a potential prototype authoring tool designed for users with no programming experience in the creation of Internet Interventions. The aim of the tool was to reduce the involvement of a professional software developer. The pilot study demonstrated that the requirements of the paper-based NEXUS Study could be replicated on a web-based platform. Although the functionality provided by the authoring tool was very limited, feedback from three types of evaluation sessions with potential users recognised the potential of such a system and provided formative feedback for progression of the software. The evaluations also reiterated the importance of providing an easy to use interface, which could be used on an infrequent basis by users with limited computer experience.

Chapter 5 Identification and Evaluation of an Authoring Tool

5.1. Introduction

The prototype authoring tool described in the previous chapter supported the hypothesis that provided with a useable tool, healthcare researchers could create standard functionality Internet Interventions, without the involvement of professional software developers. Although the tool provided the functionality for some of the more common features identified in developing Internet Interventions it was a first prototype, lacking in functionality and did not provide a generic solution capable of being used in subsequent studies.

While identifying a possible funder and writing a bid to transform the prototype into a fully functional solution the project team became aware of a competing solution in development at the University of Southampton. “*Development and evaluation of a Behavioural Intervention Grid (BI-Grid)*” (Williams *et al*, 2010, Yardley *et al*, 2010), a three year project funded by the ESRC (2008-2011), with the aim to “*develop, evaluate and disseminate an Internet-based set of resources (the LifeGuide) that will allow researchers to flexibly and collaboratively create and modify their own Internet-delivered behavioural interventions.*”. The reasoning behind the requirement of such a tool was very similar to that identified by this author:

- Lack of existing tools

- Reliance on professional software developers
- Cost
- Inability for reuse

An initial investigation was undertaken to match the functionality provided by LifeGuide to the requirements and components identified as essential in the creation of Internet Interventions.

5.2. LifeGuide

LifeGuide is an open source software solution designed to be used by non-programmers in the creation of web-based behaviour change interventions. Similar to the prototype discussed in Chapter 4, LifeGuide provides two distinct functions, intervention design and intervention delivery. The intervention designer/authoring tool is a standalone PC based solution; interventions are uploaded to the LifeGuide Community Server for testing and ultimately to provide access to study participants.

5.2.1. LifeGuide Authoring Tool

The researcher creates the pages which make up the intervention in the authoring tool or intervention designer (Figure 5.1). The underlying logic to control the page order; dynamic content visualisation; randomisation and user management is all written in one intervention logic file.

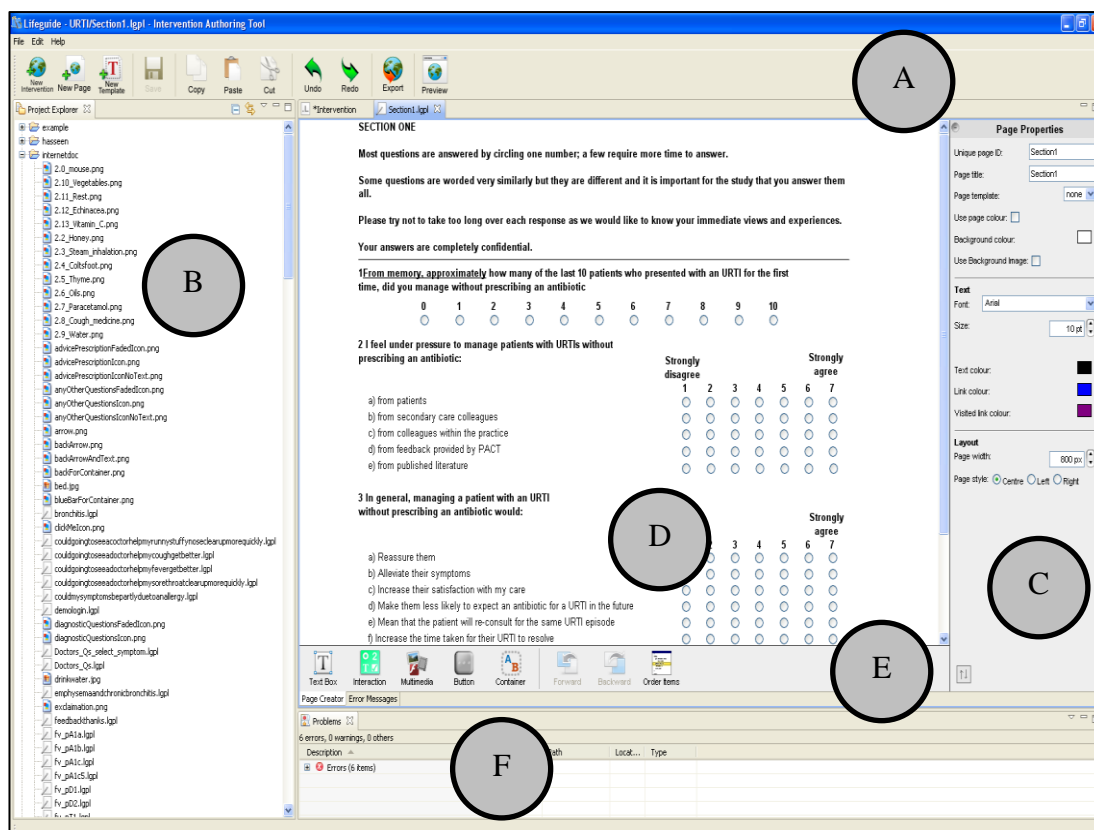


Figure 5.1 The LifeGuide authoring tool interface

The authoring tool is made up of six main sections (Table 5.1):

Section	Title	Description
A	Main Menu	Similar to most applications allowing for new interventions, adding pages, saving and editing functionality
B	Project Explorer	Contains all the files within the project/intervention folder
C	Properties Menu	Allows manipulation of the page or components such as naming, styling or placement properties
D	Page Author	The design panel on which components are added
E	Component Toolbox	Provides options for all the components available such as text boxes, questions with various response types, multimedia features and buttons for navigation
F	Error Panel	Any errors detected within the command logic will be displayed in this panel

Table 5.1 LifeGuide Authoring Tool Sections

5.2.2. LifeGuide Community

Following the intervention creation stage the intervention package is then uploaded to the LifeGuide community website for deployment through a web-based delivery platform (Figure 5.2). The community website allows users to remotely share interventions for comment by the project team or potential users.

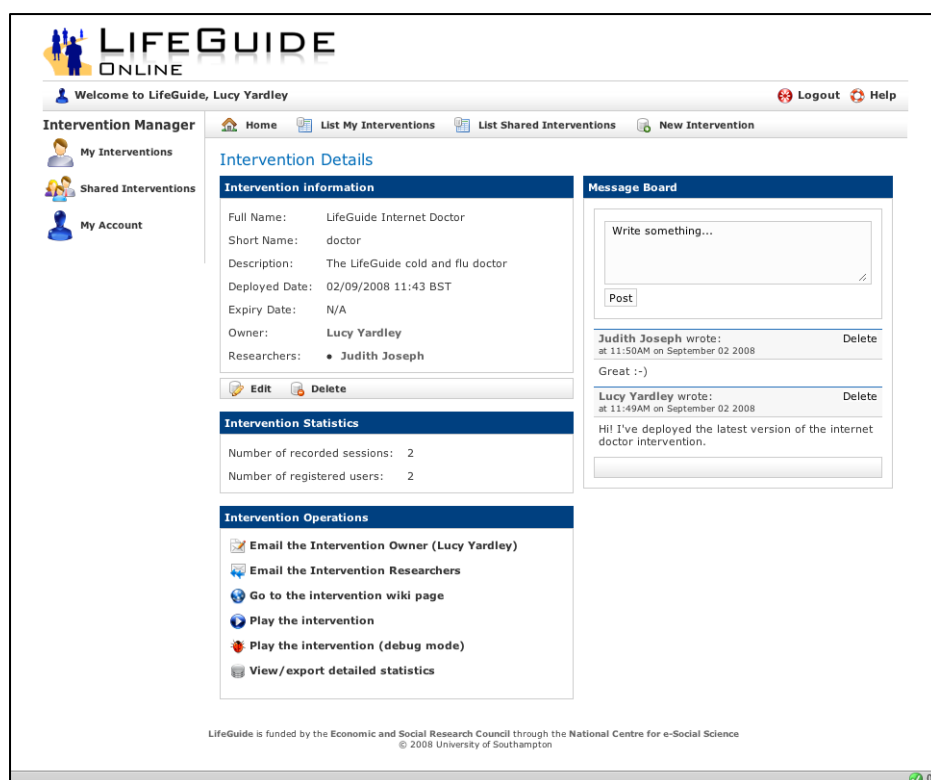


Figure 5.2 The LifeGuide Community Website

The community website collects the user responses to be exported for analysis. Logging page flows, including duration and number of accesses is automatically collected (Figure 5.3).

Intervention Sessions

Information	
Intervention:	repeat9
Number of sessions:	15
Number of non-anonymous users:	4
Export Data	

Sessions List

Id	Participant Identifier	Date	Duration
8174	anon	06/01/2011 14:31 GMT	0.0 seconds
8175	part8	06/01/2011 14:32 GMT	11.437 seconds
8176	part8	06/01/2011 14:32 GMT	9.646 seconds
8177	anon	06/01/2011 14:33 GMT	0.0 seconds
8178	part8	06/01/2011 14:34 GMT	10.671 seconds
8179	anon	06/01/2011 14:37 GMT	0.0 seconds
8180	anon	06/01/2011 14:39 GMT	0.0 seconds
8181	part10	06/01/2011 14:39 GMT	16.487 seconds
8182	part10	06/01/2011 14:40 GMT	45.660 seconds
8183	part10	06/01/2011 14:41 GMT	5.104 seconds
8184	anon	06/01/2011 14:41 GMT	0.0 seconds
8185	anon	06/01/2011 14:46 GMT	0.0 seconds
8186	part11	06/01/2011 14:47 GMT	4.337 seconds
8187	part11	06/01/2011 14:47 GMT	48.475 seconds
8188	part11	06/01/2011 14:48 GMT	32.134 seconds

Page Views

Page Name	Number of views
ConfirmVoucher	4
Consent	3
Section1Page1	7
Section1Page2	3
Section1Page3	2
Section1Page4	2

Figure 5.3 Example of the logging functionality with the LifeGuide Community website

The overall LifeGuide package was evaluated by the author with a specific focus on matching the mandatory intervention requirements identified in Chapter 3 with the functionality provided by LifeGuide (Table 5.2). Heuristic evaluations were also carried out by three usability experts from the School of Computing, University of Dundee.

5.2.3. LifeGuide Evaluations

5.2.3.1. Match with Internet Intervention Requirements

Tool Requirements	Description

Dual-purpose	As described LifeGuide provides both intervention design and delivery interfaces.
Multimedia	Text, images, video and flash animation capability, no audio functionality
Navigation	Button flow between pages
Response Capture	Response types provided – text entry, radio buttons, check boxes, scales and drop down boxes
Logic	Command line logic interface
User Management	Through logic interface or the community website
Logging	Page access, duration and flow logged through the community website

Table 5.2 LifeGuide match with Internet Intervention Requirements

The combined LifeGuide package – LifeGuide Authoring tool with the LifeGuide community website provide the mandatory functionality required in the creation of standard Internet Interventions as defined in Chapter 3. Pages can be created containing multiple data capture components, enhanced by multimedia technology and further styled through standard text editing functionality. Navigation is handled by the use of buttons and links. A command line interface provides the logic functionality required for basic arm randomisation; to allow for dynamic tailoring; user management; calculations; storage of additional variables and provides the

facility to send email. Further user management and the logging functionality are delivered through the community website.

5.2.3.2. LifeGuide Heuristic Evaluations

The LifeGuide package successfully demonstrated the functionality criteria required of an Internet Intervention creation tool. The next stage in the investigation of LifeGuide was to determine whether the tool could in fact be used by the target user group. The declaration by the LifeGuide group is that the tool is designed for non-programmers, the main benchmark standard identified in the Chapter 3 user characteristics. To verify this statement, focusing on usability three heuristic evaluations were undertaken. The evaluations identified a number of minor usability issues within two of Nielsen's main heuristics – terminology and consistency.

Examples of issues identified included:

Terminology Issues

- Pixel measurements potentially confusing for basic computer users
- Edit menu varies depending on the type of page
- 3 interaction types – single/multiple choice, text entry and numeric, terms don't match underlying components.

Consistency Issues

- Page dimensions – can change width in pixel values but not height.
- Font sizes use two different scales depending on the menu option standard pt. scale or a range from 0-7.

- Error/feedback messages can have the same name as other components – which can lead to errors in the underlying logic which requires unique nomenclature.
- Option for page colour and background colour, not an obvious difference between the uses of these.

These issues could easily be rectified to create a more user friendly interface; however a significant usability issue was identified by all three evaluators regarding the creation of logic by users with no programming experience.

5.3. LifeGuide Logic

As mentioned logic is required in the creation of Internet Interventions at a minimum level:

- To display pages in order
- For validation
- For dynamic tailoring
- User management
- Randomisation
- Calculations
- Sending email

LifeGuide adopts a command line interface for the creation of logic (Figure 5.4).

Users are required to enter key words and syntax such as brackets/parentheses,

commas and quotation marks in a pre-specified format in order to utilise the functionality mentioned above.

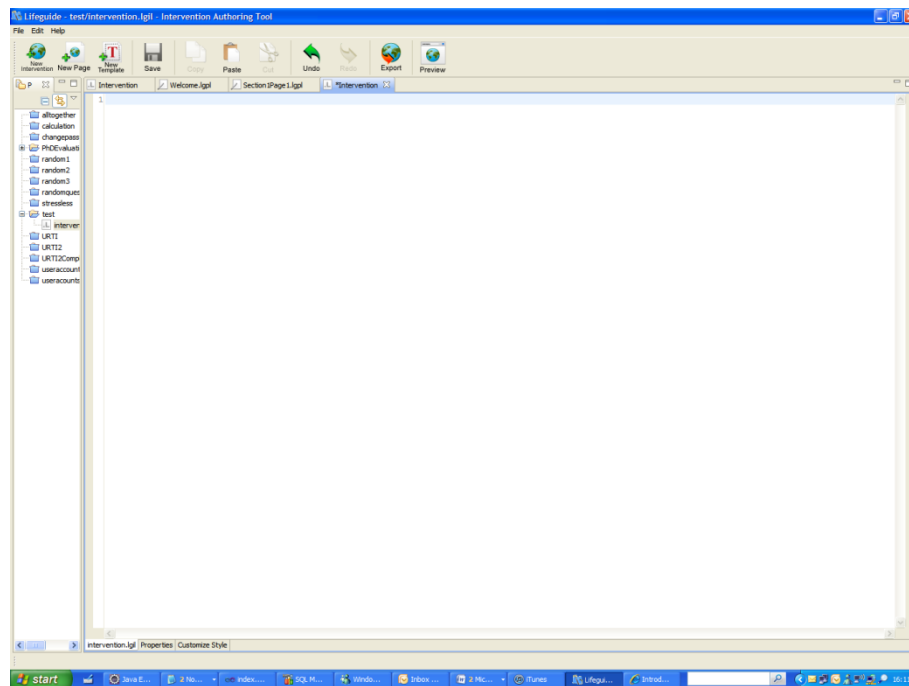


Figure 5.4 LifeGuide Logic Interface

The logic interface exploits the use of colour to aid user interaction with the interface, where key commands are highlighted in red text and commands displayed in pink text. A pop up menu also serves as a reminder of the available commands, page names and components; however this is displayed on an inconsistent basis.

Basic examples of the logic required to facilitate the functionality required in most standard Internet Interventions includes:

1. Display Page Example

Show	Welcome
Show	Consent

Figure 5.5 LifeGuide Logic – Display Pages

The logic command to display a page in LifeGuide is **Show** (Figure 5.5). This example displays a page named `Welcome` followed by a page named `Consent` page.

2. User Management/Validation

```
Show Welcome  
After if Welcome  
if (authenticateuser(Welcome.userid, "password")) goto Consent  
Show Consent
```

Figure 5.6 LifeGuide Logic – User Management

LifeGuide provides five main user functions - create users, validate users are registered to access the intervention (Figure 5.6), change password, check the user account has been activated, and check the user exists. The example above (Figure 5.6) displays a `Welcome` page; if the participant is an authenticated user of the intervention the `Consent` page is displayed.

3. Dynamic Tailoring

Incorporating dynamic tailoring into an Internet Intervention can lead to a more immersive experience through personalization, and allows for the removal of redundant/irrelevant questions based on participant's previous answers.

```
Show Gender  
After Gender if (Gender.GenderOption, "Male") goto MalePage  
Show FemalePage  
Show MalePage
```

Figure 5.7 LifeGuide Logic – Dynamic Tailoring

An example of dynamic tailoring could be asking the gender of a participant (Figure 5.7) with different pages displayed depending on the response captured.

4. Basic Randomisation

```
set theRandom to randomnumber(0,1)
savevalue(Page.UserName,"Arm",theRandom)
After Page if (theRandom,0) goto Arm0
Show Arm1
Show Arm0
```

Figure 5.8 LifeGuide Logic – Randomisation

LifeGuide provides the facility for the basic ‘*coin toss*’ style of arm randomisation (Figure 5.8), suitable for studies with large numbers of participants. More complex randomisation algorithms currently require external implementation.

5. Send Email

LifeGuide provides functionality to schedule the sending of emails from an intervention, this is particularly helpful for sending reminder emails or keeping track of participants completion status. The `sendemail` command (Figure 5.9) provides an example of a function which has a strict parameter list. This type of syntax is a concept users with programming experience are familiar with, but would still require some learning time, however non-programmers would be required to identify the command, where brackets and commas are required and to manually calculate when to send the email (the last parameter is time in seconds before sending).

```
sendemail(Email.ID, Email.EmailAddress, Email.Subject,
Email.Content, Email.WhentoSend)
```

Figure 5.9 LifeGuide Logic – Send Email

Although the logic programming language is unique to LifeGuide this type of command line syntax should not be excessively difficult for users with previous programming experience to learn. However as mentioned the LifeGuide Authoring tool is targeted at users with no prior programming expertise. The evaluators felt that even with access to example logic files, through the community website, novice

users would experience great difficulty hence the heuristic rating of a major usability issue.

5.4. Summary

This chapter identified a potential authoring tool to be used in the creation of Internet Interventions. In June 2014 the LifeGuide Authoring Tool (current version available since Feb 2011) had been downloaded 1019 times, with over 170 live trials running and nearly 1700 users signed up to the community website (LifeGuide Group, University of Southampton, 2014). On investigation this tool was found to achieve the requirements of an Internet Intervention tool as identified in Chapter 3, primarily serving as a dual purpose package for the creation and delivery of interventions but also providing the functionality to allow for navigation between pages and sections; intervention enhancement through multimedia inclusion and user response capture through multiple response types. Logic creation is a recognised major requirement of an Internet Intervention authoring tool. Although logic creation is provided by the LifeGuide software, the command line interface used to enter the required logic was found to be inappropriate for the target user group i.e. users with no programming experience.

The following chapter describes the development of a Graphical User Interface (GUI) alternative to LifeGuide with the aim of removing the necessity for users to learn any programming syntax or technical terminology.

Chapter 6 Design of a Graphical User Interface

6.1. Introduction

The LifeGuide Authoring Tool in combination with the community website provides the functionality to design the types of web-based interventions described throughout this thesis with relative ease. However the creation of the underlying logic required in the control of an intervention was identified as a potential area of difficulty for healthcare researchers who typically have no previous programming experience.

6.2. Case Study: Reduction of Inappropriate Prescribing

The two year project: “*Developing and evaluating interventions to reduce inappropriate prescribing of antibiotics in primary care: comparison of paper-based and web-based modelling experiments*” funded by the Chief Scientist Office (CZH/4/610) between 2010-2012, provided the opportunity to not only confirm the viability of delivering another intervention modelling experiment via a web-based platform but also to develop an augmented interface to aid users with no programming experience in the creation of intervention logic (Treweek *et al*, 2011).

6.2.1. Study Design

The healthcare focus for this multi-disciplinary project was in the area of antibiotic prescribing in the Primary Care setting. Cochrane reviews of the effectiveness of antibiotics in treating upper respiratory tract infections (URTIs) suggest no benefit in

colds (Arroll, 2005) and only marginal benefit for uncomplicated sore throats (Mar *et al*, 2004). Theory-based paper interventions were previously developed and evaluated targeted at reducing unnecessary prescribing of antibiotics corresponding to the theoretical, modelling and experimental phases of the MRC Framework (2008). Similar to the case study presented in Chapter 4, this project involved the comparison of a Web-Based Intervention Modelling Experiment (WIME) with the original paper-based approach presented by Hrisos *et al* (2008), described in Chapter 2.

The aim of the study was:

1. To compare the web-based and paper-based methods of running IMEs in terms of identification of predictors, the type of intervention that can be simulated, effect on intended prescribing behaviour and the logistics of running an IME.
2. To run a WIME to develop and evaluate theory-based interventions to reduce antibiotic prescribing for URTIs in primary care.
3. To improve the user-friendliness and applicability of the LifeGuide software to clinical decision-making.

The following research questions were:

1. Do paper-based and web-based systems identify the same predictors of GP behavior regarding prescribing of antibiotics for URTIs?

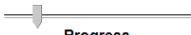
2. Can a web-based IME system provide trialists with richer and more predictive information upon which to base the development of behavioural change interventions than paper-based IME systems?

6.2.2. Implementation

The study followed a two stage approach targeted at GPs across Scotland. In Stage 1 the GPs were invited to respond to a web-based questionnaire (Figure 6.1) which included simulated clinical scenarios (Figure 6.2), with the purpose of identifying predictors of GP antibiotic prescribing behavior. The scenarios were altered slightly to include a local prescription pad image as the original paper IME took place in England. Embedded within this stage was an evaluation of participant response rates of email versus postal invitations to participate.

	Strongly disagree	1	2	3	4	5	6	Strongly agree
5. It is highly likely that patients with an URTI will be worse off if I manage them without prescribing an antibiotic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
6. How confident are you in your ability:	Not at all confident	1	2	3	4	5	6	Extremely Confident
a) To manage patients with URTIs without prescribing an antibiotic?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
b) To end a consultation for a patient with an URTI who you have managed without prescribing an antibiotic?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
c) To manage a patient whose URTI symptoms are distressing to them, without prescribing an antibiotic?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
7. a) When I see patients with URTIs, I automatically consider managing them without prescribing an antibiotic	Strongly disagree	1	2	3	4	5	6	Strongly agree
b) It is my usual practice to manage patients with URTIs without prescribing antibiotics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
c) I aim to manage patients with URTIs without prescribing an antibiotic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

Back



Progress

Next

Figure 6.1: Example Questionnaire Page

Case 1 of 8. Miss Kay Hamilton, 104 Dene View Place, Othertown		Age 26 years
Active Problems : Nil	Current medication : Microgynon : Co-codamol	Smoker : 10 / day
Significant past : Substance Misuse 2005 : Therapeutic termination of pregnancy 2003		Occupation : Beautician
HISTORY : Sore throat 2 days, "can't swallow", Feels awful. "I always need antibiotics"		
EXAMINATION: Red throat, tonsils not enlarged, nodes +, tender		
DIAGNOSIS:	MANAGEMENT:	
On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?		
Not at all difficult 1 2 3 4 5 6 7 8 9 10 Extremely difficult		
If you wish to comment on this decision please do so here		
<div>Back</div> <div>Progress</div> <div>Next</div>		

Figure 6.2: Example Simulated Scenario

In Stage 2 participants were randomised to control (no intervention), persuasive communication intervention (Figure 6.3) taken from the paper-IME or a new action plan intervention (Figure 6.4) developed from the results of Stage 1. Following the intervention participants were requested to complete a post-intervention questionnaire, again including simulated scenarios.

Primary care practice involves a large range of clinical decisions, often made under pressure of time. These decisions have consequences not only for the immediate clinical condition of the patient but also for the way patients perceive the effectiveness of treatments and the role of the GP in their ongoing care.

Below is a series of pictorial scenarios, depicting some of the consequences for the GP of deciding to manage URTIs with or without antibiotics.

Dr A, in the first row of scenarios, **manages URTIs by prescribing antibiotics**, while **Dr B**, in the second row of scenarios, **manages URTIs without prescribing antibiotics**.

Beneath the scenarios are questions to help you to consider the possible **consequences of each doctor's prescribing habits**

Dr A manages patients with URTI by prescribing antibiotics

Penicillin 3 times daily

"I'm worried about our Colin, he's got a dreadful cough and a sore throat."

"You should take him to Dr A for some antibiotics."

"More sore throats – does Dr A have any appointments left for this week?"

"I'm sorry I gave you my cold, here, have some of the antibiotics Dr A gave me."

"Not another four extra's with sore throats wanting antibiotics!"

Next

Figure 6.3: Persuasive Communication Intervention

Introduction			
<p>There may be situations where you feel under pressure to prescribe an antibiotic. Having a specific plan for what you will do instead of prescribing an antibiotic in these situations will help you to end a consultation without prescribing and thus follow more evidence-based practice. Below are two situations that GPs in this study have said to be more difficult ones in which to avoid prescribing. In the column beside these situations are examples of action plans which could help reduce inappropriate prescribing in these situations.</p> <p>Target: Reduce prescribing of antibiotics for URTIs</p>			
Situation	Example of action plans to avoid prescribing an antibiotic in these situations		
1. A patient with an URTI specifically asks for an antibiotic, or clearly expects to be prescribed an antibiotic	<p>if a patient asks for an antibiotic, then I will provide them with a clear reason for not prescribing which emphasises my professional expertise e.g. <i>Your URTI is likely to be caused by a virus and an antibiotic won't help. You are more likely to have side-effects than benefits if I prescribe an antibiotic.</i></p>		
2. A patient with an URTI (or the patient's parents) are very distressed about their symptoms	<p>if a patient (or parent) is distressed about their symptoms, then I will</p> <ul style="list-style-type: none"> a) reassure them by stressing that they will recover b) tell them that an antibiotic will not help them and c) I will give them something to do so they can feel more in control and relieve symptoms (e.g. <i>drink hot water with lemon and honey as necessary through the day</i>) 		
<p>How is progress/success of the action plan to be monitored? I will count the number of times I succeed in managing an URTI without prescribing an antibiotic</p>	<p>When will this happen? Daily for one week</p>	<p>Who in the practice will monitor plan progress? I will</p>	
<div>Print</div> <div>Next</div>			

Figure 6.4: Action Plan Intervention

6.2.3. Intervention Development

The questionnaires, scenarios and interventions were developed by the author using the LifeGuide Authoring Tool again with the primary focus on early and continuous user involvement and evaluation with rapid prototype development. Prototypes were repeatedly evaluated within the project team which included GP representation, before a pilot evaluation was undertaken by 10 GPs external to the project. The pilot was used to gather completion timing information in order to offer appropriate compensation to participants in the live study. The main pilot findings related to:

- duration of time to complete
- question fatigue
- use of colour to enhance the interface
- option to decline voucher for participating
- indication of progress

Unfortunately the first three points could not be addressed in this trial, in order to reflect a true consistent comparison with the paper study. The option to participate without requesting a voucher was added to the voucher selection screen. A progress bar was also added to the bottom of every page to indicate to participants how far through the session they had advanced.

6.2.4. Study Results

270 GPs took part in stage one of the study where 8 out of ten predictors of GP prescribing behavior were in agreement between the paper and web-based IMEs. These predictors were used to develop the new action plan intervention which formed the 3rd randomisation arm adopted in Stage 2. The second stage involved 131 GPs, where those who received the interventions indicated an increase in the number of scenarios without an antibiotic prescription. The email vs postal invite sub-study reported the same effectiveness for both methods however email delivery was found to be cheaper and more efficient to implement (Treweek *et al*, 2012). Again the study demonstrated that IMEs can be effectively delivered on a web-based platform (Treweek *et al*, 2014).

6.3. Design of a Graphical User Interface

The third aim of the study was to improve the user-friendliness of LifeGuide with a particular focus on the logic creation interface. This activity ran in conjunction with the questionnaire, scenario and intervention development, as experience in using the tool was gained. The remainder of this chapter describes the development of a

Graphical User Interface (GUI) or Visual Programming Interface alternative to the LifeGuide command line interface, designed for users with no previous programming experience. The proceeding chapter reports on the findings from a summative evaluation of LifeGuide as standard and in combination with the GUI.

The LifeGuide logic interface is defined as a command line interface. From the 1960s command line interfaces were the principle method of interaction with computer systems until the 1980 - 1990s, which saw the introduction of Graphical User Interfaces (GUI). In order to determine the most appropriate interface type for the LifeGuide alternative interface, accessible by the target user group, a background investigation into potential types of interface design and programming interfaces was undertaken.

6.3.1. Interaction Styles

Stone *et al* (2005) identified five primary interaction styles with associated advantages and disadvantages (Table 6.1):

Type	Interaction Style	Overview
Command Line	Allow for direct instruction to the system through a defined set of commands, syntax and character sets.	This type of interaction appeals to expert users as it provides flexible interaction. Requires substantial training and memorization of commands.
Menu Selection	Involves users selecting from	Appropriate for learners or

	a set of options either using a pointing device like a mouse, through a series of key strokes or through speech interfaces.	infrequent users but has the potential to be slow in use due to too many levels.
Form-fill	Adopting the metaphor of a paper form, users enter data and make selections from the form presented.	Provides a simple data entry method suitable for the collection of large amounts of information but consumes screen space
Direct Manipulation	Labelled WYSIWYG (What You See Is What You Get) interfaces allow users to interact directly by dragging and dropping and clicking on objects.	Easy to learn and remember, allows for minimal error and encourages exploration but with the risk of interpretation differences of screen metaphors.
Anthropomorphic Interfaces	These interfaces aim to simulate human to human interaction through natural language and gesture recognition.	Remove the burden of learning syntax but can be difficult to implement

Table 6.1 Interaction Styles

The initial investigation identified menu selection and direct manipulation as potential interfaces for the target user group profile of infrequent users with limited computer experience. Direct manipulation was selected as the most applicable

interface; menu selection was discounted due its potential for slowness attributed with multi-level menu structures.

The next stage of the background investigation focused on the identification of programming languages designed to lower boundaries to learning programming for beginners.

6.3.2. Programming Interfaces

Similarly to the issues highlighted through the heuristic evaluations undertaken on the LifeGuide logic interface in Chapter 5, Kelleher and Pausch (2005) and Soloway (1986) suggest potential barriers for non-programmers to learn to program relate to cognitive load and associated frustration in remembering rigid syntax and rigid commands. Kelleher and Pausch also describes two main motivations for learning to program, the pursuit of programming as a career path or in the case of healthcare researchers learning to program in the pursuit of another goal i.e. the creation of Internet Interventions.

Kelleher and Pausch suggest programming for beginners can be more approachable through simplification of the language, tailoring the language for a specific small domain and by prevention of syntax errors. The LifeGuide programming language already existed through the command line interface. The new interface design had to simplify the language and prevent errors but still allow users to become familiar with the commands already in place, to avoid additional learning and to provide a

seamless connection between the existing LifeGuide interface and the new GUI interface.

6.3.2.1. Simplification and Error Prevention

Simplification of the language syntax can in turn lead to reduction of errors through the removal of symbols such as brackets, commas and semicolons. Both the Turing Language (Holt and Cordy, 1988) and Junior Java (JJ) (Motil and Epstein, 1998) provide simplification through the removal of semicolons and braces (JJ). Grail (McIver, 1999) adopts the use of 'x' rather than '*' to represent multiplication, a symbol which users with a basic level of mathematics will already be familiar with. Syntax errors can also be reduced or prevented through the use of predefined templates containing placeholders such as the Cornell Program Synthesizer (Reps and Teitelbaum, 1989). The tile based visual programming language Kodu Game Lab (Fowler *et al*, 2012) eliminates syntax errors by only presenting relevant or syntactically correct tiles to the user. In addition if a tile or section of code is removed associated tiles are also removed to prevent subsequent errors.

Kelleher and Pausch suggest taking this a step further by bypassing syntax problems such as parentheses and cognitive issues relating to remembering commands and ordering through the adoption of movable objects. Object manipulation or visual programming (Daly, 2009) allows for code creation in a graphical environment where objects represent the underlying code. The metaphor of blocks as the graphical object has been adopted in several programming interfaces such as LogoBlocks (Begel, 1996), designed with a low threshold for learning and Scratch

(Resnick *et al*, 2009) designed around the idea of “*tinkerability*”. Programs can be created by “*snapping*” blocks together through a drag and drop interface, shape cut-outs define which blocks can be “*snapped*” together. In addition to the block interface Pet Park Blocks (Cheng, 1998) provides the option for users to view the underlying textual translation allowing for gradual transition to command line programming.

Most software tools including operating systems, statistical analysis packages, database management tools and word processing packages provide optional interfaces to cater for varying levels of user experience. The alternative manipulation methods range from menu selection, direct button interaction, short-cuts keys through to command line interaction (Figure 6.5).

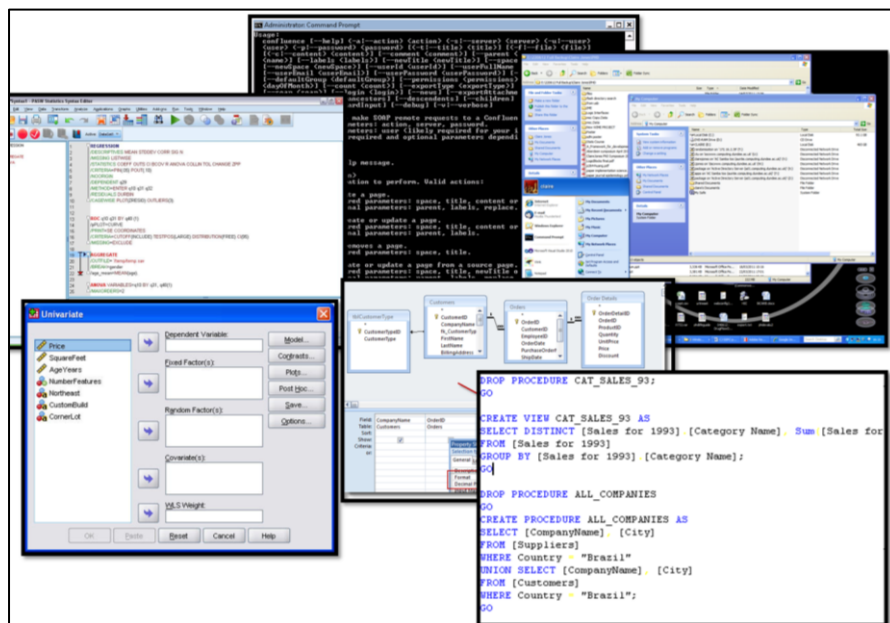


Figure 6.5: Interface Interaction Alternatives

LifeGuide in combination with the alternative interface would provide healthcare researchers with the flexibility to select which interface is most suited to their skill

set. Kelleher and Pausch also support the use of multiple mechanisms for interaction in the area of learning to program.

From the background investigations and focusing on the logic functionality provided by LifeGuide the most applicable design to aid the target population in the creation of Internet Interventions was deemed to be a Graphical User Interface, specifically a block based approach adopting direct manipulation. The provision of short-cut functionality is desirable for users as they gain in experience.

6.3.3. Design of LogicBlocks

The development of the GUI, which became known as LogicBlocks followed the same development lifecycle as discussed throughout this thesis in the creation of Internet Interventions. A rapid prototyping methodology was adhered to with early and continuous involvement and evaluation initially with potential users within the project team, latterly with external users. Based on the heuristic evaluations carried out on LifeGuide in Chapter 5, an initial static mockup (Figure 6.6) was created as part of the CSO funding application.

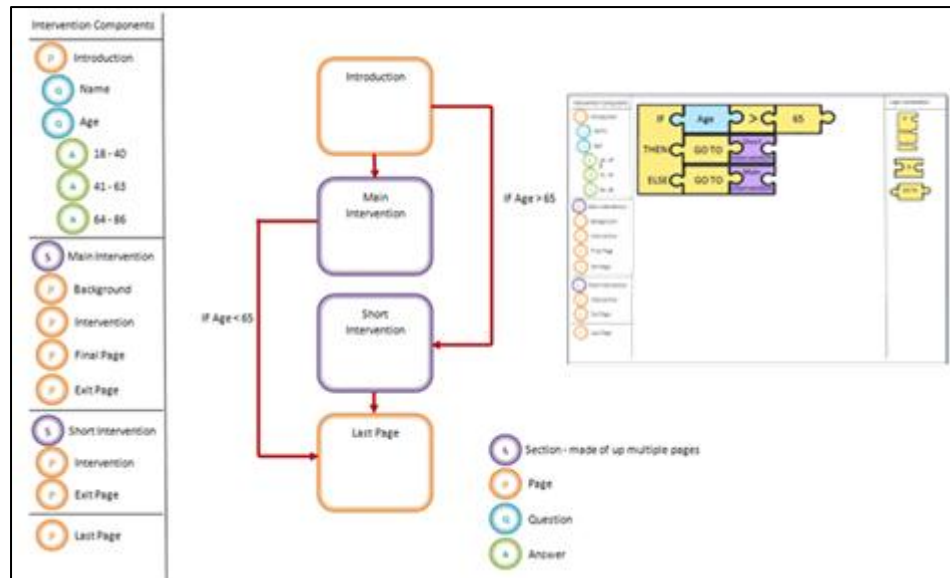


Figure 6.6: Initial Prototype – Graphical User Interface to LifeGuide

Following the successful CSO grant application and subsequent to the interaction styles investigation discussed, a card sorting technique was embraced prior to paper prototyping, horizontal and vertical prototyping, and finally concluding with a final software prototype.

6.3.3.1. Card sorting

The first stage in the development of LogicBlocks was to identify all the commands and functions available in LifeGuide. Using the LifeGuide online dictionary each command was written down on a piece of paper with a short description of usage. Five members of staff from the School of Computing, University of Dundee with variable computer experience were invited to participate in individual in-person card sorting sessions (Usability.gov, 2014) with the author as an observer. Participants were asked to organise the commands (Figure 6.7) into appropriate groups and then give each group a collective representative name.

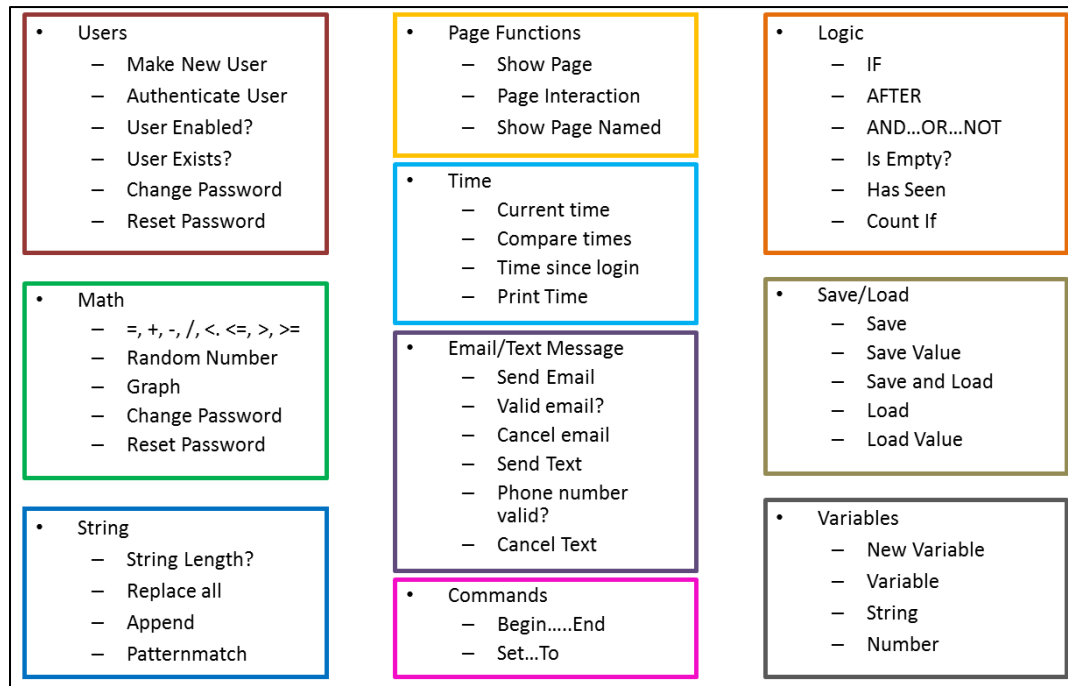


Figure 6.8: Functional Grouping of Commands

6.3.3.2. Design Metaphor

As discussed throughout the previous chapters the target user group interested in creating Internet Interventions will typically be infrequent users with limited computer experience. Therefore in the design of the visual objects used to manipulate the underlying code in the GUI it was imperative to focus on intrinsic knowledge, through the *Principle of Exploiting Prior Knowledge*. Focusing on ‘*Knowledge in the head, knowledge in the world*’ and mental models a jigsaw metaphor was adopted with the aim of allowing users to create logic devoid of previous capability. Hand drawn and basic computer drawn blocks were designed for each of the commands based on the rules for usage and parameters required, as defined in the LifeGuide Logic Dictionary. Two main areas were identified with the aim of creating a more user –friendly interface and to avoid potential syntax error through the use of the jigsaw connection types, templates and prepopulated fields.

6.3.3.3. Jigsaw Connectors

The blocks or jigsaw pieces were designed focusing on cognitive load reduction where only complimentary connectors can be joined together. Three main block prototypes were developed:

1. Function Return Blocks

A function returning a value is common practice in the world of programming, however for this target user group this is a new concept. To alleviate this learning curve, blocks were designed with a flat left side i.e. no return value, to indicate they do not require to be joined to any other block (Figure 6.9) whereas blocks with a node attachment on the left i.e. returning a value require to be joined to other blocks (Figure 6.9). In addition to the node attachment, commands which have a return value also have a further indicator they have to be joined through the use of question mark in the command label, a subtle hint that the block is returning an answer (Figure 6.9).



Figure 6.9: Example of commands with/without a return value

2. Function Parameters

Another core concept for programmers is object types, again possibly unfamiliar for non-programmers. There are two distinct object types in the creation of LifeGuide logic: pages and variables. To aid recognition commands which require pages to be

connected have a ‘<’ connection type where as those that require variable connections (Figure 6.10) have a ‘(‘connector.



Figure 6.10: Example of page and variable connection types

3. Code Grouping

The LifeGuide logic allows for grouping commands into sections. This is particularly useful for code readability and reuse especially in the case of participant randomisation; the code relevant to each arm can be grouped into sections. Two blocks were designed which represent the start and end of a section of code; these blocks have internal horizontal connectors (Figure 6.11).

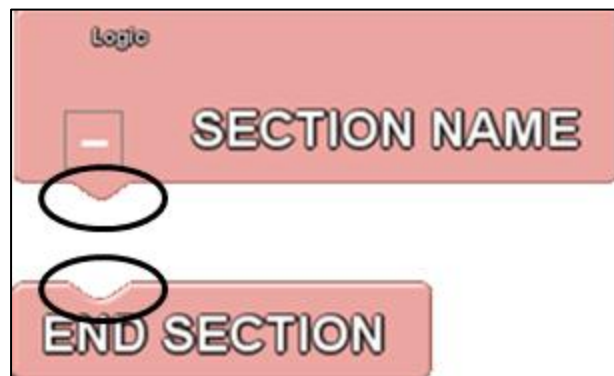


Figure 6.11: Example of section command blocks

6.3.3.4. Templates and Pre-populated Fields

Another familiar concept for programmers is functions which utilise a parameter list. In LifeGuide the parameters have to follow a specified order separated by commas and surrounded by parentheses. An example of this type of parameter functionality is the command to send an email:

```
sendemail("unique name for e-mail", e-mail address,
"Subject message for e-mail", "E-mail content", number
in seconds indicating how long to wait before sending
the email)
```

Similarly certain commands can only be used in combination, following a strict specified order otherwise errors will occur. An example is the IF command which can only be used with IF...AFTER...GOTO, IF...SHOW and IF...SET...TO. Similarly to the Cornell Program Synthesizer (Reps and Teitelbaum, 1989) previously discussed, to avoid errors and again to ease the cognitive load on the user, template block mock-ups were designed. These blocks have text label reminders and hover over descriptors to provide quick hints relating to command usage.

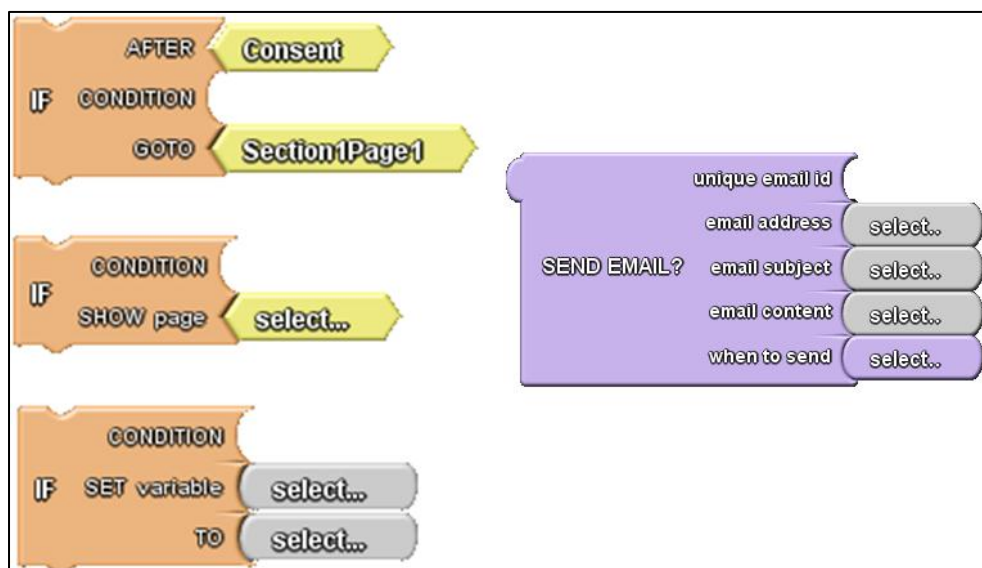


Figure 6.12: Example of template blocks

In combination with the templates, pre-populated fields were also considered with a focus on the *Principle of Recognition* where '*recognition is better than recall*'. Interventions consist of various pages which are further divided into components such as question responses and feedback messages, each of these have unique names which the user is required to remember in order to use in the intervention logic. The

pre-populated fields would contain all of the page and component names included in an intervention and allow the user to make a selection from a drop-down menu (Figure 6.13).

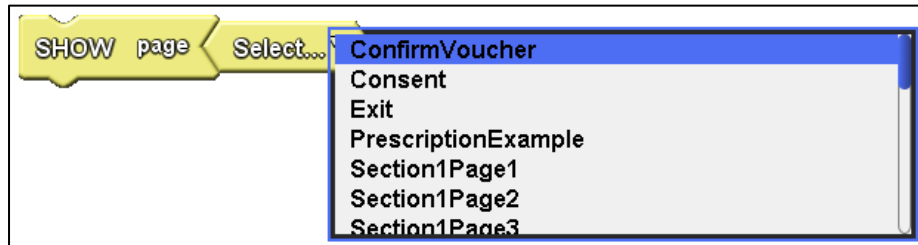


Figure 6.13: Example of pre-populated fields

Another design included relating to pre-population is associated with the command to send an email. The last parameter relates to the time delay in seconds from instigating the email trigger to sending it. Unless the emails are sent immediately i.e. time = 0 the user would need to calculate the time manually. The design of the parameter was changed to include send “Now” or to select from a date/time calendar.

Following the design and prototyping of the blocks which represented all the commands and rules available in the LifeGuide logic language a paper prototype of the potential block interface was produced.

6.3.3.5. LogicBlocks Paper Prototype

The block interface represents a direct manipulation interaction. To maximise screen real-estate and to conform to the *Principle of Perceptual Organisation* and the *Principle of Importance* the related block groups identified through the card sorting technique were grouped accessible through a menu structure. The paper prototype

menu utilised a drawer type metaphor where the paper was lifted to display all the possible commands available in that colour coded group (Figure 6.14).

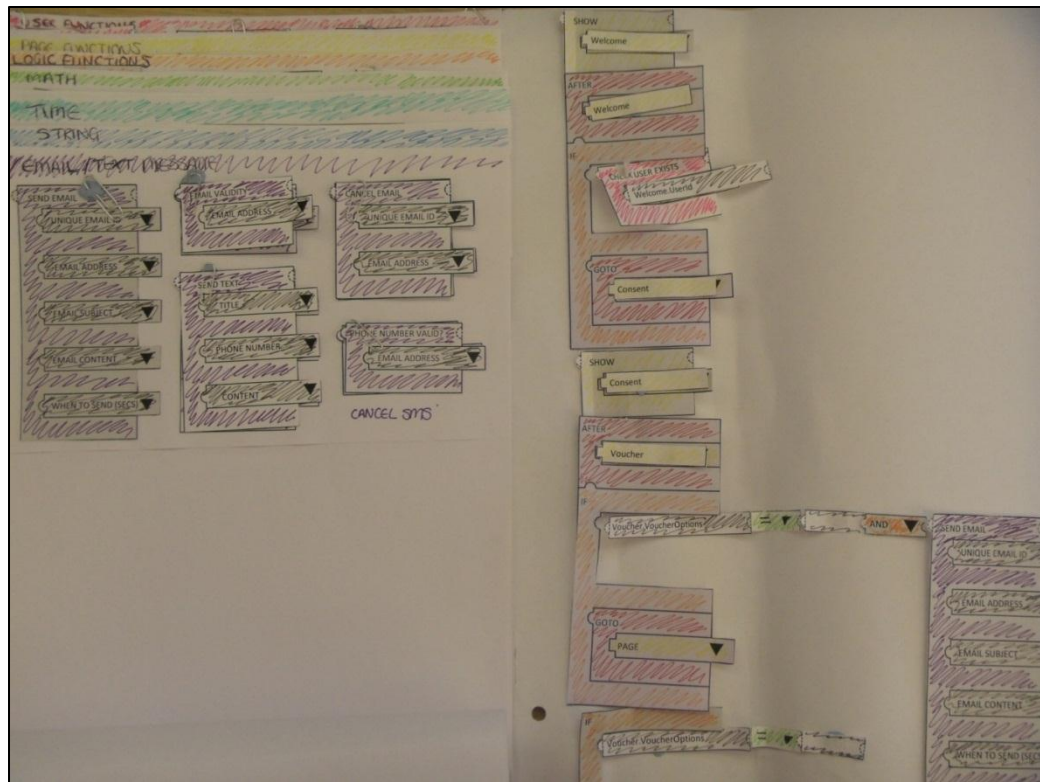


Figure 6.14: LogicBlocks Paper Prototype

Paper prototyping with ‘Wizard of Oz’ testing was identified as a useful approach for testing proposed intuitive interfaces to hard-to-use “expert-only” systems (Snyder, 2003). The paper prototype was evaluated using the ‘Wizard of Oz’ approach through three one-hour sessions by potential users from within the project group. The participants were asked to replicate the logic for the URTI prescribing intervention described at the onset of this chapter. The evaluation consisted of three tasks where each task added an additional layer of complexity.

1. Displaying a page (Object types)
2. Validation of registered participants (branching logic, return types)
3. Send an email (templates and pre-populated fields)

When the users selected either the menu or pre-populated fields the author simulated the computer interaction and displayed a paper equivalent of the underlying menu.

The evaluation served to confirm the menu groupings, the jigsaw connectors and template designs.

6.3.3.6. LogicBlocks Horizontal Prototype

Based on the evaluation feedback the paper prototype was translated into a horizontal prototype developed in Flash MX. The prototype was designed to confirm a software version of the block structure and menu access, as with the concept of horizontal prototypes limited functionality was provided for a subset of blocks. Particular focus was paid to the *Principle of Usability* and the *Principle of Feedback* where it should be obvious to users which interface components afford interaction and subsequent notification when they have been selected. An accordion metaphor was used to represent the ten menu options with drop down menu access for pre-populated fields (Figure 6.15).

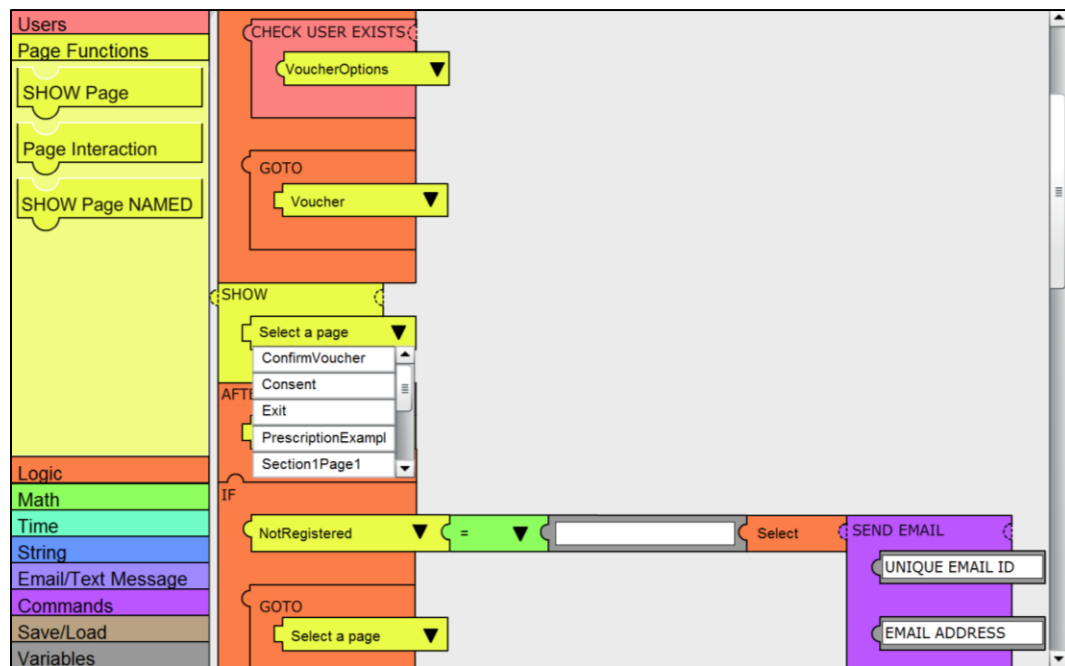


Figure 6.15: LogicBlocks Horizontal Prototype

The prototype was again evaluated within the project group using the prescribing intervention as the basis for the logic required in a typical healthcare intervention.

6.3.3.7. LogicBlocks Vertical Prototype

The aim of designing the interface was to demonstrate that provided with a usable interface a non-programmer could generate intervention logic. The decision was made to implement the interface by customising the open-source OpenBlocks, Java library from MIT (Roque, 2007), which has been successfully adopted in multiple areas all relating to ease of learning to program such as Scratch (Resnick *et al*, 2009) and LogoBlocks (Begel, 1996). OpenBlocks allows for block manipulation through a drag and drop interface. Syntactically correct blocks are combined by ‘*snapping*’ complementary connectors together. OpenBlocks ‘*snaps*’ the blocks into place. Vicinity information, different connection types and the deletion of blocks through a bin metaphor are also standard functionality provided by the library. The interface

such as the menu structure, block templates and associated blocks are defined through a customised XML definition. The development effort for the vertical prototype (Figure 6.16) focused on the design of the interface with continuous involvement from the project group. A major component of the interface development involved parsing the block output into the relevant LifeGuide syntax and format to be communicated back to the LifeGuide Authoring Tool for execution.

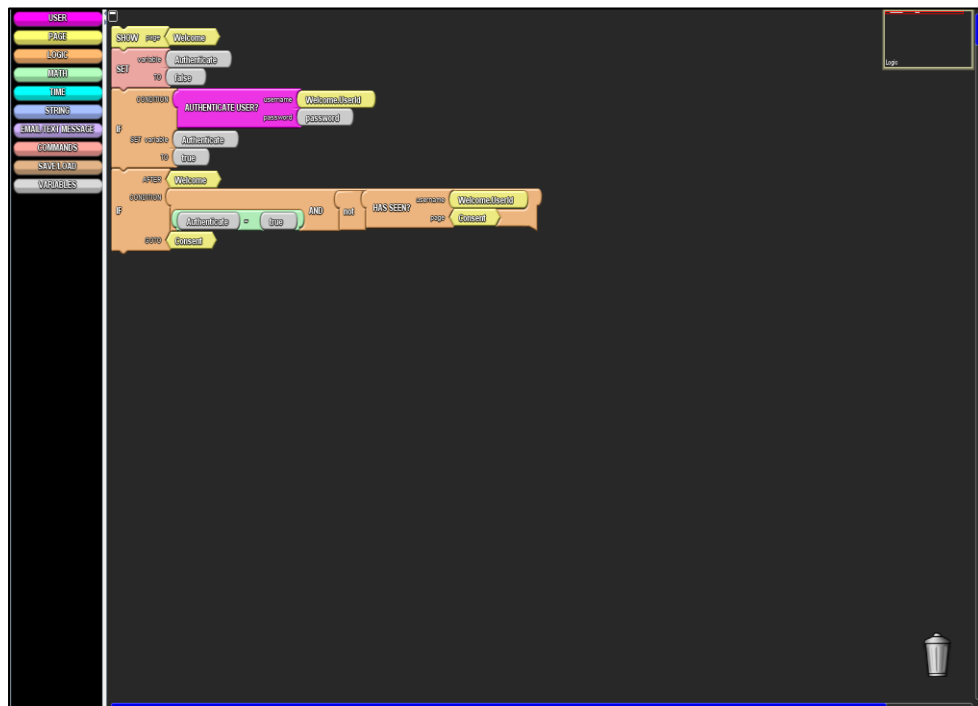


Figure 6.16: LogicBlocks Vertical Prototype

As standard practice the interface was iteratively evaluated before the feedback was built into the final prototype.

6.3.3.8. LogicBlocks Final Prototype

The final iteration of the prototype focused on furthering the usability of the interface with the addition of the following enhancements:

The final prototype was evaluated initially in a pilot evaluation to test out the evaluation methodology before a summative evaluation was undertaken by thirty participants in a randomised comparator task-based experiment. The successes of the interface and evaluation findings are reported in Chapter 7.

External Tool

LogicBlocks was developed externally to the LifeGuide Authoring Tool. A work around was developed to allow page and interactions names to be extracted from LifeGuide and intervention logic exported from LogicBlocks back into LifeGuide simulating a combined package. Ultimately the two interface options would be provided as view options within LifeGuide, allowing users to fluidly flow between interfaces depending on their level of experience.

6.4. Summary

This chapter initially discussed the development of an Internet Intervention in the field of inappropriate prescribing in the Primary Care setting. Again the project group comprised of a multi-disciplinary team; a professional software developer was required to create the Internet Intervention due to the lack of a suitable tool for non-programmers. The web-based intervention modelling experiment (WIME) including questionnaires, simulated scenarios, a persuasive communication and an action plan successfully demonstrated that the IME methodology could be effectively delivered over a web-based platform.

In tandem with the intervention development, a Graphical User Interface (GUI) was designed and developed to aid non-programmers in the creation of LifeGuide logic. Similar to all of the software developments discussed in this thesis the development of the GUI followed a rapid prototyping lifecycle with early and continuous involvement from the target user population. The development focused on usability design principles supporting “*Any application designed for people to use should be easy to learn (and remember), useful, that is contains functions people really need in their work and pleasant to use*” (Gould and Lewis, 1985).

The initial paper prototype was created followed by three iterative cycles of software prototypes. The success of LogicBlocks is revealed in the ensuing chapter described through a summative evaluation specifically focused on usability metrics.

Chapter 7 Measuring the Success of the Interface

7.1. Introduction

In designing an experiment to evaluate the LogicBlocks interface, it was necessary to identify the key novel aspects that would differentiate it from previous research. The evaluation served to compare two interfaces designed specifically to facilitate the creation of intervention logic by non-programmers. LogicBlocks was designed adopting a user-centred design approach with early and continuous user involvement with rapid prototyping. Earlier chapters have explained the desire and necessity; the design and development of LogicBlocks with a central focus on user-centred and interface design techniques. This chapter focuses on reporting the success of the interface by measuring and evaluating the usability of LogicBlocks. The success was measured based on the 5 Es identified in Chapter 2: efficiency; effectiveness; engagement; error tolerance and ease of learning, the multi-faceted characteristics of usability (Quesenbery, 2001). The experimental process and results are reported based on the Consolidated Standards of Reporting Trials (Consort) (Schulz, 2010).

7.2. Objectives

7.2.1. Hypothesis

The hypothesis of this experiment was that:

“LogicBlocks will increase user satisfaction, learnability, the task completion rate, reduce errors, task completion time and duration of access to support documentation when creating Internet Interventions compared to the current command line interface provided by the LifeGuide Authoring Tool”

7.3. Trial Design

A multicentre task-based experiment was adopted implementing a within-group design, with unblinded balanced randomisation, conducted across 5 sites in North, East and Central Scotland. A ‘walk-up-and-use’ design metaphor was employed in the experiment to assess the complexity of task that a user could achieve using both LifeGuide and LogicBlocks with minimal instruction and no additional help simulating current practice.

LogicBlocks was designed following user-centred design techniques, adopting the functionality currently available within the LifeGuide Authoring Tool, necessary to create Internet Interventions i.e. to incorporate the most commonly used functionality required. The task design was developed using previous experience and investigations into the example resources and tutorials provided by the LifeGuide community. The objective of the experiment was to devise a set of realistic tasks that could feasibly be undertaken within a one hour session whilst simulating a real-world example. Furthermore the experiment aimed to provide a basic level of understanding of the underlying logic concepts required in a typical Internet Intervention. The experiment duration of an hour was based on previous

experience of study recruitment i.e. how much time participants are willing to give and seeking to prevent fatigue and cognitive overload. The task design was incremental, with each task increasing in difficulty and building on the previous tasks. The tasks were designed to demonstrate to participants what they could achieve in a relatively short time period, how the functionality could be replicated in their own studies and that although the content and healthcare focus varies between projects the fundamental steps in development are the same.

7.3.1. Sample Web-based Project

The antibiotic prescribing Web-based Intervention Modelling Experiment (WIME) described in Chapter 6 was selected as a platform on which to base the experiment. Particularly to demonstrate to participants how LifeGuide has been utilised in a ‘*real-world*’ study. The LifeGuide Authoring Tool provides an intuitive interface to develop the pages of an Internet Intervention by users with limited computer experience. The purpose of this experiment was to focus on the logic creation required in the control of an Internet Intervention not on page creation. Specifically the aim was to evaluate LogicBlocks; a Graphical User Interface (GUI) designed to enable non-programmers to create intervention logic. Therefore all the pages and interactions required were predefined for use by the participants, standard naming conventions were adopted. The task design required the participants to replicate the logic required to implement the prescribing WIME i.e. page flow, user management and dynamic tailoring, all of which form the basis of the studies discussed throughout this thesis.

7.3.2. Experiment Scenarios

Four distinct tasks were designed to cover the most commonly used features of an Internet Intervention page flow, user management, dynamic tailoring and randomisation. A subsequent retention task was developed based on user management but also with the addition of email functionality. The task descriptions were purposely high-level, requiring numerous steps to be carried out but with the potential for successful completion in a variety of ways whilst covering a wide range of the applications functionality.

7.3.2.1. *Practice Task*

A practice task would serve to familiarise the participants with the LogicBlocks and LifeGuide environments, providing an opportunity to interact with the menus and access the Help facilities provided. Each Internet Intervention consists of a series of pages, the most commonly used function in Internet Intervention development is simply displaying pages and determining page flow. The task required the display of a Welcome Page followed by a Consent Page (Appendices 7, 8). The logic command required to display a page in LifeGuide is `Show` followed by the page name e.g. `Show Welcome`.

Task Complexity – 2 commands, 2 variables

7.3.2.2. *Task 1 – User Management*

An online resource has the potential to be discovered by anyone. User management can prevent this unauthorised access and subsequent data submission; allows for logging such as number of visits, flow through pages and time spent and most

importantly to store matched participants responses. A typical task therefore is to verify that the user credentials provided are those of an authorised user of the resource, this forms the basis of Task 1 – User Management (Appendices 9, 10). Building on the practice task, the participants were asked to verify user credentials before displaying the next page which in the case of the prescribing WIME was a Consent Page, this task involves a two- step process: a logic branching test condition and the relevant user management command. In LifeGuide this is handled by the `if` and `authenticateuser` commands.

Task Complexity – 4 commands, 3 variables, 1 string interaction

7.3.2.3. Task 2 – Dynamic Tailoring

Personalisation of an Internet Intervention can lead to higher user engagement (Kreuter, 2003). Logic is required to dynamically tailor an Internet Intervention based on the participant's previous responses leading to a more personalised experience and resulting in participants only being asked questions or viewing content which is relevant to them. This provides the potential to cut down on questionnaire length by the removal of redundant questions and also eliminates the need for participants to have to navigate around questions. An example of this type of branching question could be a non-smoker being asked how many cigarettes they smoke a day or 'skip to question 10' as seen in many paper questionnaires.

Again basing the task on the antibiotic prescribing study and following on from the previous tasks, the next task was to dynamically display a page dependent on the respondent's selection from a list of voucher options. If the respondent selects they

are *'not interested'* in taking part an exit screen is displayed containing the study contact details, if they select a voucher such as Amazon from the list of available vouchers a confirmation page is displayed (Appendices 11,12). This task makes use of the `if` branching logic command, the `=` comparison operator and optionally the `not` operator, while repeating the basic functionality of displaying pages in order.

Task Complexity – minimum 10 commands, 9 variables and 2 string interactions.

7.3.2.4. Task 3 – Arm Randomisation

Randomising participants to different arms is a desirable feature of many studies, particularly Randomised Controlled Trials (RCTs). In the case of Internet Interventions this could involve displaying different pages to participants depending on the group they were assigned to. In the case of the antibiotic prescribing WIME participants were randomised to control, action plan or persuasive communication, where each intervention had a distinct set of pages. The task design was to randomly allocate participants to control, action plan or persuasive communication groups. A simple random number generator is required to generate a random number between 0 and 2 representing the 3 groups followed by display of the relevant pages after the voucher confirmation page. This task makes use of the `randomnumber`, `set` and `section` commands and again reuses the `if` and `show` commands.

Task Complexity ~ 21 commands, 15 variables, 3 integers

7.3.2.5. Retention Task

The user profiling investigation identified that healthcare researchers would be involved in the creation of Internet Interventions on an infrequent basis. Specifically concentrating on the ease of learning measurement a hypothetical retention task was designed to be undertaken by a subset of participants 6 weeks post experiment. The task built on the user management functionality by creating a new user through logic commands. Account validation such as preventing duplicate usernames is automatically handled within LifeGuide. This task also demonstrated the enhanced facilities available within LifeGuide which allows for sending emails, a feature which was found to be extremely useful in the antibiotic WIME. The task specification (Appendices 13, 14) was to display a sign-up page which would allow a respondent to set up a user account with a unique username; the sign-up process was confirmed through the process of sending a confirmation email. This task implements the `makenewuser` and `sendemail` commands.

Task Complexity – 7 commands, 7 variables and 3 string interactions.

7.4. Pilot Study

A pilot study was conducted with six participants to validate the experimental design methodology, specifically focusing on participant documentation, task complexity and session duration.

Participants were recruited from the departments of Population Health Sciences, Tayside Clinical Trials Unit and the School of Computing, all from the University of

Dundee. All 6 participants had been previous involvement in projects which developed healthcare interventions and were interested in utilising a web-based approach. Three participants had previous programming experience. A relatively informal evaluation was conducted with participants requested to provide feedback on the experiment design as they worked through the tasks. No quantitative outcome measures were recorded. Particular focus pertaining to the experiment delivery; facilitator's script; duration of task completion and experiment documentation including information sheets, questionnaires and task descriptions were considered.

Participants had previously collaborated with the author as part of a multidisciplinary team focusing on healthcare research. Participants were not familiar with the prescribing WIME, LifeGuide or LogicBlocks. The descriptive reasoning provided for the experiment was the evaluation of two potential interfaces to facilitate programming logic. Interface order was randomly assigned with 3 participants viewing LifeGuide then LogicBlocks and vice-versa.

7.4.2. Pilot Findings

Two main experimental design issues were immediately identified relating to the '*walk-up-and-use*' approach and the experiment time restrictions.

7.4.2.1. 'Walk-up-and-use' Metaphor

It was found that this control type approach resulted in conceptual overload for participants. Participants were coming to the experiment with no prior information before commencing the actual task; they had to grasp the concepts involved in the creation of Internet Interventions e.g. page/logic separation; how to manually create the pages in LifeGuide; how the pages and logic link together and how to interact with the both LogicBlocks and LifeGuide neither of which they had seen before. There was found to be too many concepts to comprehend within the hour period.

7.4.2.2. Experiment Duration

Time constraints resulted in all participants only managing to complete the practice task and two tasks in combination with the associated questionnaires in order to reserve time for debriefing. Although the tasks individually did not consume a vast quantity of time on their own when combined with the welcome dialog, introductions, questionnaires and set up the third task could not be completed within an hour.

7.4.2.3. Questionnaire Alterations

Minor alterations to questionnaire wording were highlighted through the pilot evaluation, such as clarification of instructions.

7.4.3. Changes to Trial Design

7.4.3.1. *Participants*

The original specification for the development of the LogicBlocks interface was to facilitate logic creation for non-programmers, or infrequent users. However to avoid restricting usage to this target group and to obtain a balanced opinion of the interface it was decided eligibility would not be restricted to non-programmers.

7.4.3.2. *Instructions video*

The pilot phase highlighted the requirement for three instruction videos focusing on:

- How to create pages in LifeGuide.
- How to create logic, access help and interact with the LifeGuide command line interface.
- How to create logic, access help and interact with the LogicBlocks interface.

The videos also ensured there was no deviation from the instruction script providing consistency across all participants. Wink screen recording software was used to capture the videos and augmented with instruction notes.



Figure 7.1: Example Instruction Video Screenshot

7.4.3.3. Task Reduction

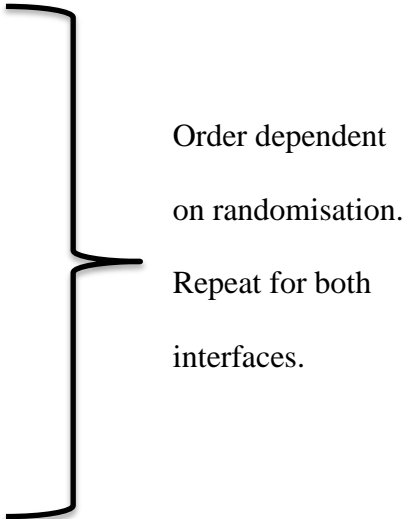
To allow for more discussion time, the incorporation of the instruction videos and to avoid potential experiment fatigue the third task relating to randomisation was removed.

7.5. The Experimental Process

All participant documentation including the Information Sheet (Appendix 3, and Participant Consent Form (Appendix 4) and the experiment design was approved by the School of Computing Ethics Committee, University of Dundee. An experimenter script was produced to standardise the instruction/introduction process.

Participants were provided with the Information Sheet describing what the experiment entailed and how the resulting data would be used. A Consent Form was

provided for signing, if the participant wished to proceed. Participants were informed they could request clarification on the task requirements but no instructions would be given as to how to complete the task. Participants were also informed that they could withdraw at any point. The following process was defined and followed for evaluation sessions:

1. Baseline questionnaire to obtain experience with logic (Appendix 6)
 2. Introduction – Participant Information
 3. Introduction to LifeGuide Page Authoring Tool - video
 4. Instruction video for interface
 5. Practice Task (Appendices 8, 9)
 6. Task 1 – User Management (Appendix 10, 11)
 7. After Task Questionnaire (Appendix 6)
 8. Task 2 – Dynamic Tailoring (Appendix 12, 13)
 9. After Task Questionnaire (Appendix 6)
 10. After Interface Questionnaire (Appendix 7)
 11. Debriefing
- 
- Order dependent
on randomisation.
Repeat for both
interfaces.

7.5.1. Participants

Eligible participants were all adults aged 18 or older who had an interest in developing Internet Interventions. As mentioned restrictions on the eligibility criteria which prevented participants with programming experience were removed. The only exclusion criterion was non-English speakers.

7.5.2. Study settings

The experimental sessions took place during September 2012 with follow up retention tasks in November 2012 at the Universities of Stirling, Dundee and Aberdeen, in either the participant's office or a meeting room.

7.5.3. Hardware and Software Requirements

A laptop running Windows 7 was provided to participants to conduct the experiment with the following software installed: Eclipse to run LogicBlocks, the LifeGuide Authoring Tool, Wink Screen Capture and Internet Explorer to view the Help Guide. An external mouse was attached to the laptop. The LifeGuide Help Guide is currently only available as an online resource however it could not be assumed that Internet functionality would be available at external sites therefore a local copy of the Help Guide was produced.

7.5.4. Measuring/logging software

During the experiment it was important to be able to record as much pertinent information as possible regarding each participant's interactions. Screen recording software was therefore used to record all aspects of activity including video recording of mouse and keyboard actions. Audio was captured using an audio recording application on a mobile phone.

7.5.5. Interventions

The experiment was designed to compare two interfaces, the graphical user interface of LogicBlocks and the command line interface provided by LifeGuide. A within-group design was implemented in order to obtain a comparative opinion from the same participants regarding both interfaces and to avoid potential effect due to different participant groups. The order of which interface the participants evaluated first was randomly assigned to avoid the potential for learning effect.

7.5.6. Observers/Facilitators

The author was the main facilitator at all sites however in order to reach the target recruitment numbers an additional facilitator with an experience in user-centred design and evaluation facilitated experiments at both the Aberdeen and Dundee sites. To maximize exposure to the experiment the additional facilitator was firstly a participant, before undergoing training in the delivery of the experiment. The facilitator was provided with the experiment script and instructions. The author acted as an observer in the additional facilitator's first session.

7.5.7. Outcomes

The aim of LogicBlocks was to facilitate the creation of Internet Interventions by non-programmers. The success of the interface is reported through usability outcome measures for both LogicBlocks and LifeGuide including user satisfaction, learnability, task completion rate, error rates and reliance on support documentation.

7.5.7.1. Primary Outcomes

The five usability characteristics include effectiveness, efficiency, engagement, error tolerance and ease to learn. The methods used to capture these measurements are described in Table 7.1.

Characteristic	Type of Usability Measure
Effective	Task completion status defined by the participant
	Task completion percentage defined by the author (%)
	Correct use of commands and syntax
Efficient	Duration of task (time in seconds)
Engaging	IBM Computer Usability Satisfaction Questionnaires
	Qualitative coded analysis during tasks and the session debriefing
Error Tolerant	Total error count coded analysis following participant indicated task completion/abandonment
Easy to Learn	Coded analysis, count of number of times accessed help
	Duration in help (time in seconds)
	Retention Sub-study qualitative analysis

Table 7.1: Usability Measures

7.5.7.2. Secondary Outcomes

Secondary outcome measures include analysis of error types and frequency of errors for both LifeGuide and LogicBlocks interfaces as well as qualitative coded analysis of participant's free text comments and closing statements.

7.5.8. Sample Size

The experiment was designed to collect both qualitative and quantitative results. Based on Roscoe's Rule of Thumb for small samples (Roscoe, 1975) and Nielsen's recommendation for quantitative usability testing (Nielsen, 2006) a sample size of 30 participants was required to offer a tight confidence interval. Qualitative usability analysis requires fewer participants as usability problems are normally detected with lower numbers of participants; Turner *et al* (2006) acknowledge three to five subjects, supported by Nielsen (2006) who recommends five participants.

7.5.9. Randomisation

A closed-sequence balanced-randomisation list of 40 allocations was generated to accommodate for potential loss of participants. Participant identifiers were sequentially allocated from 1-40. Randomisation was semi-blinded in that the participants were self-selecting depending on their availability. Each participant was assigned the next available pack.

7.5.10. Similarity of interventions

Participants were provided with a description of LifeGuide with a focus on the creation on intervention pages. The descriptive reasoning for the experiment was the evaluation of two potential interfaces in the creation of logic by a healthcare researcher. No indication was given on the creator of either interface. The same functionality was available through both LifeGuide and LogicBlocks specifically the command set available. In order to prevent potential bias an equivalent help manual

was produced for LogicBlocks replicating that of the LifeGuide Help Manual. The textual logic dictionary was adapted to display the graphical block commands in place of textual examples but with identical descriptions of usage.

7.5.11. Statistical methods

All data collated in the experiment was analysed using SPSS Version 10. Built in functions were used to perform calculations such as means, standard deviations and statistical tests. A p value of less than 0.05 is reported as significant.

As discussed the primary outcomes measures were efficiency, effectiveness, engagement, error tolerance and ease of learning. A combination of tests were used to determine the significance of results, repeated measures ANOVA's were performed to measure percentage task completion, task duration and after-scenario user satisfaction. Aligned Rank Transformations (ART) (Wobbrock *et al*, 2011) were performed before analysis using repeated measures ANOVA's for count data specifically counts of number of errors, overall interface satisfaction and number of times help was accessed. Duration of time in help was analyzed using Friedman's ANOVA and Chi Square adopted to report on interface preference.

7.5.12. Additional analyses

Audio recordings and screen capture videos were coded using Atlas Ti Qualitative Data Analysis and Research Software adopting a grounded theory test-retest approach.

Ancillary covariate analysis included gender, age, computing experience and interface order interactions for all outcome measures.

7.5.13. Losses and exclusions

One participant withdrew from the experiment after the initial introduction; she was interested in learning about the research but misunderstood that she was required to participate rather than spectate at a research presentation.

7.5.14. Recruitment

Recruitment took place during August and September 2012 at five sites experienced in the field of healthcare research (Table 7.2):

- Site 1: University of Stirling, Nursing, Midwifery and Allied Health Professions Research Unit (NMAHP)
- Site 2: University of Aberdeen, The Institute of Applied Health Sciences, Health Psychology Group
- University of Dundee:
 - Site 3: Division of Population Sciences
 - Site 4: School of Computing
 - Site 5: School of Nursing and Midwifery

Site	Invitation	No. Invited	No. Responses	Experiment Date
Site 1	28/08/12	27	5	04/09/12
Site 2	16/08/12	22	7	11/09/12
Site 3	31/08/12	100	10	Throughout August 2012
Site 4	22/08/12	5	5	Throughout August 2012
Site 5	10/09/12	72	3	20/09/12

Table 7.2: Recruitment Details

The participant recruitment strategy took three approaches all based on email invitation (Figure 7.2). Email canvassing was adopted at the Division of Population Sciences Site; direct participant invites were made to relevant participants from the School of Computing and a direct individual contact was made at the remaining three sites who distributed the email to relevant participants. Follow up emails were sent to respondents to arrange a suitable session schedule.

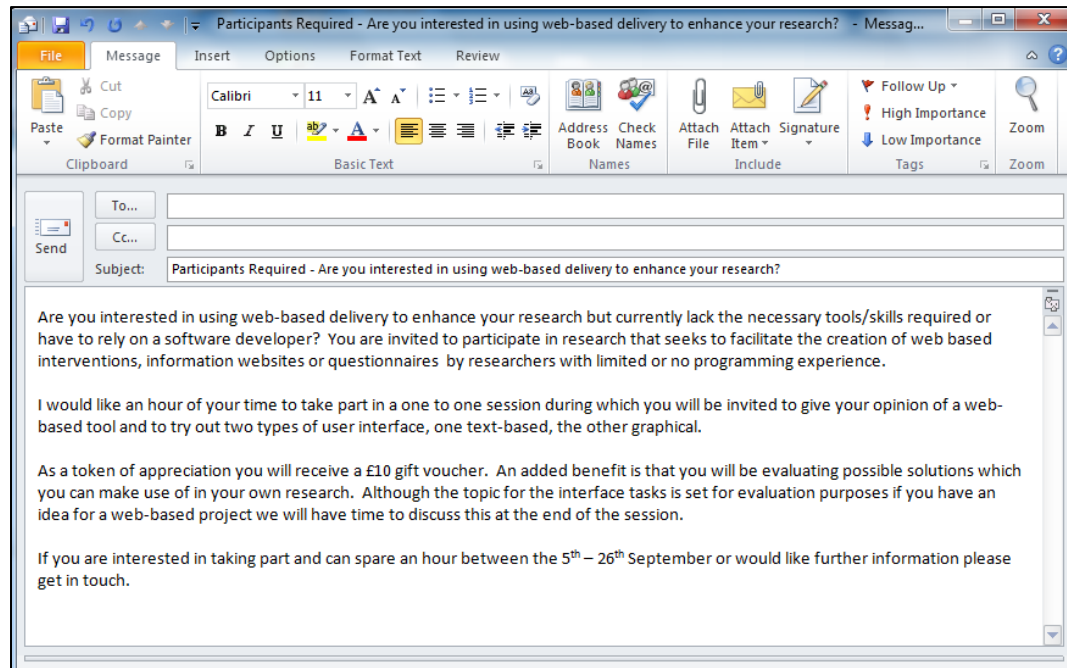


Figure 7.2: Recruitment Email

7.5.15. Retention

The retention task was carried out 6 weeks post-experiment with 6 participants who took part in Phase 1 of the evaluation. Participants were from the School of Computing and the Division of Health Population Sciences both University of Dundee. Participants were specifically targeted to obtain balanced representation from both programmers and non-programmers. A between-group design was adopted for the retention task to obtain an unbiased comparison of both interfaces evaluated following equal periods of inactivity. This design was selected to simulate where possible real life interaction with the interface i.e. a delay between usage synonymous with access to such a tool by this target group. The aim of the experiment was to record the participants immediate reaction when revisiting the interface after a period without usage.

7.5.16. Compensation for Subjects

As a gesture of appreciation all participants including those who took part in the pilot study received a £10 voucher for either Amazon or M&S funded by the Chief Scientist Office (CZH/4/610) through the prescribing WIME.

7.6. Results

In this section the results of the baseline questionnaire, task-based experiments and ancillary analysis focusing on types of errors encountered is presented.

7.6.1. Baseline data

Thirty participants completed the experiment; participant flow through the system can be followed through the experiment Consort Diagram (Appendix 16). To ascertain their user profile specifically current level of computer usage, intervention development experience and logic expertise participants were asked to complete a baseline/demographics questionnaire.

7.6.1.1. Demographics

Gender distribution of participants was 2:1 female to male with an average age in the 31 to 40 years old category (Figure 7.2).

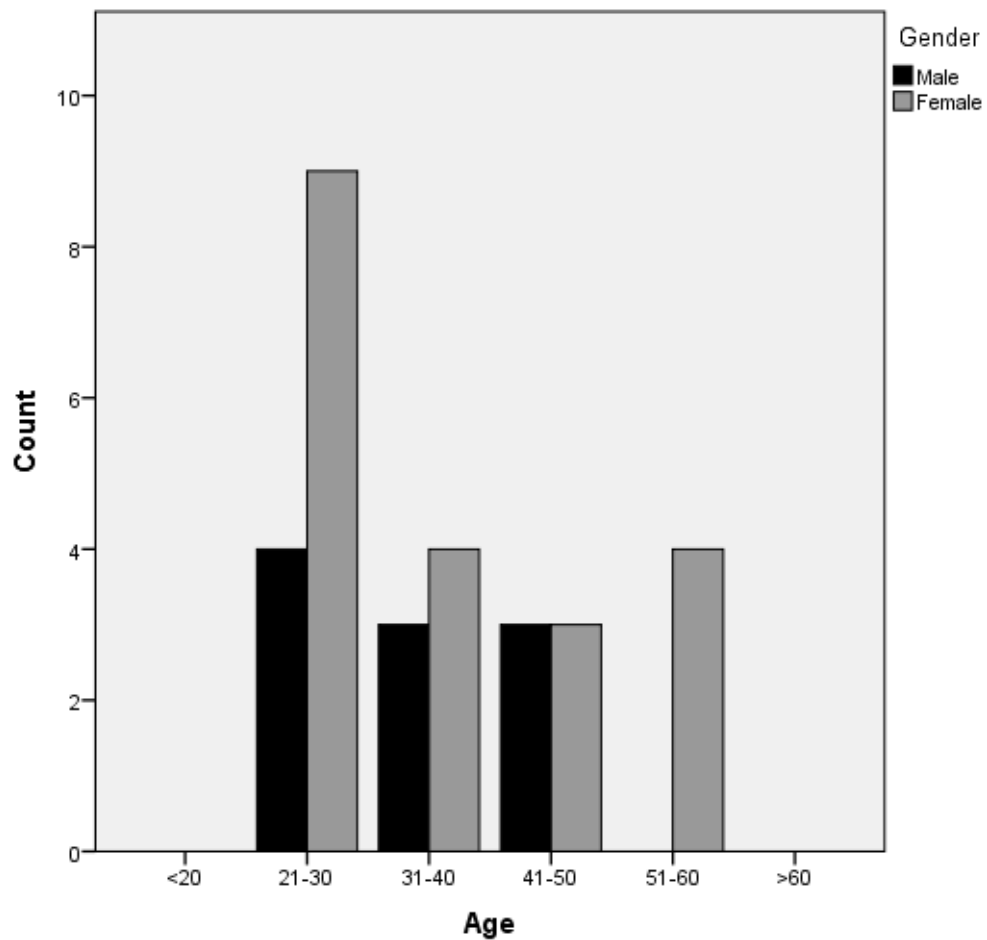


Figure 7.3: Gender/Age Distribution of Participants

As previously discussed participants were self-selecting recruited from 5 different sites, although all the participants shared an interest in healthcare research they derive from different backgrounds.

The range of occupation titles afforded grouping into the following categories (number of participants shown in brackets):

- Research Assistant (5)
- Lecturer (6)
- PhD Student (6)
- Programmer (6)
- Research Fellow (7)

Although not pre-emptively controlling for profession profiling the group size suitably fits Nielsen's Magic 5 for qualitative usability testing (Nielsen, 2006).

7.6.1.2. Computer Experience

All of the participants reported using a computer on a daily basis, utilising functionality such as Word or browsing the Internet. 80% of the participants stated computer usage as several times a day with the remaining 20% at least once a day. A combination of questions were designed to establish participants level of computing experience, comfort of usage and functionality accessed specifically focusing on graphical or command type interactions. Participants' computing expertise was gauged through rating the following statements: *"I feel comfortable with computers"* and *"How would you rate your level of computer experience"*. Both statements were scored on 5-point Likert scales, all participants rated their comfort level as neutral to strongly agree with an average rating in the agree band. Experience was rated as neutral to expert with an average rating in the nearly expert band. 90% of participants selected they could change settings but interestingly only 6 participants make use of command line functionality, all of the six program on average on a weekly basis with programming experience ranging from 1 year to 10 years. When asked to rate their programming experience the average rating for those who programme was neutral on a scale of novice to expert (Table 7.3).

Task	Frequency Count		Difficulty Rating	
Programming Experience	Yearly	3	Nearly Novice	1
Total Count: 6	Weekly	1	Neutral	3
Average Years: 7.3	Daily	2	Nearly Expert	1
			Expert	1

Table 7.3: Participant Programming Experience

7.6.1.3. Logic Experience

The evaluation hypothesis explores the use of both graphical and command line user interfaces in the facilitation of programming logic. Level of logic experience was a desirable baseline measure to evaluate if there was any correlation between previous expertise and interface. Scenarios were identified where participants may have previously encountered logic/programming type tasks but may not necessarily recognise the association if directly asked about logic expertise. Participants were asked if they had ever written formulae in a spread sheet package or syntax in a statistics packages, then asked how often and how difficult they found these tasks.

73% of participants had previous experience of writing a formula in a spread sheet package (Table 7.4) and over half had written statistical syntax (Table 7.5), both tasks were on an infrequent basis averaging monthly. Task difficulty reported an average rating of neutral on a difficulty scale from very difficult to very easy.

Task	Frequency Count		Difficulty Rating	
Spread sheet Formulae	Yearly	13	Difficult	5
Total Count: 22	Monthly	5	Neutral	8
	Weekly	2	Easy	5
	Daily	2	Very Easy	4

Table 7.4: Participant Logic Experience – Spread Sheet Formulae

Task	Frequency Count		Difficulty Rating	
Statistical Syntax	Yearly	10	Very Difficult	2
Total Count: 17	Monthly	4	Difficult	4
	Weekly	3	Neutral	6
			Easy	3
			Very Easy	2

Table 7.5: Participant Logic Experience – Statistical Syntax

Participants were asked to provide any other circumstances in which they have encountered logic or formulae and how difficult they found the task. Examples highlighted were formulas in PDF forms which the participant found “*very hard as it requires programming knowledge which I don't have*” (Participant 20), puzzles for recreation purposes found to be “*relatively easy*” (Participant 24) and SQL queries in MS Access but with no specified difficulty rating.

7.6.1.4. Resource Development Experience

Participants were asked ‘*Have you ever been involved in developing/creating healthcare related interventions, information resources or questionnaires?*’. An average of 3.7 resources had been created by 23/30 participants. A combined total of

85 interventions had been developed by the thirty participants. Three participants selected '*I developed software*' in the creation of resources, these participants are from a background in professional software development. The responses provided highlight that either paper-based interventions were adopted thus potentially missing out on the enhancements of web-based delivery or supporting the heavy reliance of researchers on professional software developers or other members of the project team (Figure 7.5).

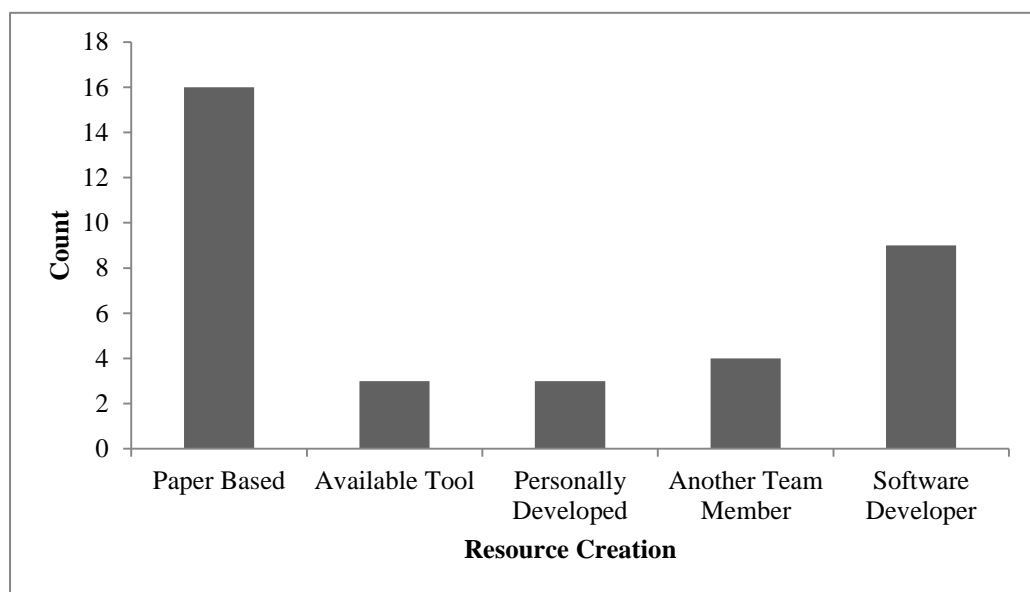


Figure 7.5: Intervention Creation Options

7.6.2. Task-Based Findings

For all tasks participants were provided with a task description sheet and screen shots of the appropriate pages created in LifeGuide with page and interaction labels highlighted.

7.6.2.1. Practice Task – Displaying Pages in Order

The aim of the practice task (Appendices 8, 9) was to allow participants to gain hands on experience of interacting with the interfaces subsequent to viewing the

intervention instruction videos. Limited support was provided to participants in the form of clarification about the task, how the logic and pages combine and how to access help facilities rather than how to actually interact with the interfaces.

All participants successfully followed through the instruction steps of the practice task by accessing the Logic Dictionary where they were asked to view the commands available. The task was completed on the creation of the logic required to display the Welcome Page followed by the Consent Page in either the textual command format or by manipulation of the block interface depending on the interface in use.

Points of Interest

Using the LogicBlocks interface it was noted that two participants tried to drag the menu options onto the main block pane, rather than clicking to open and view the list of available commands. Several participants who viewed the LifeGuide interface first were unsure how to move onto the next line when entering the second command. In both cases no prompting was given by the facilitator and was resolved by participant using trial and error.

7.6.2.2. Task 1 – User Management

An identified requirement for an Internet Intervention relates to user management functionality. Task 1 (Appendices 10, 11) focuses on the validation of user credentials where only pre-registered users are permitted access.

The research hypothesis for the overall task:

H₁: proposes that in a direct comparison task requiring the creation of logic to facilitate user validation and page display in the LifeGuide Authoring Tool, LogicBlocks will be more efficient, effective, engaging, error tolerant and easier to learn than the current command line interface provided by LifeGuide.

The null hypothesis:

H₀: proposes there will be no difference in efficiency, effectiveness, engagement, error tolerability and ease to learn in the creation of the logic required to facilitate user validation and page display when comparing the use LogicBlocks to the current command line interface provided by the LifeGuide Authoring Tool.

a. Measure of Effectiveness

Effectiveness of the interface was reported by measuring the completeness and accuracy of completion of the task as per the steps defined in the task description. Completeness was also recorded based on participant reported completion i.e. task completed or abandoned.

The research hypothesis focusing on effectiveness was:

H₁: the LogicBlocks interface provides a more effective interface in the creation of intervention logic focused on user management than the LifeGuide command line interface.

The null hypothesis:

H₀: proposes there will be no difference in effectiveness between the LogicBlocks and LifeGuide interfaces in the application of user management logic.

Participants were given no restriction on length of time to complete, and were reminded they could stop the task at any point. Participants were also reminded of the ‘*walk-up-and-use*’ metaphor and were instructed to abandon the task after the period of time they would realistically spend on a similar task.

Task Completion Status

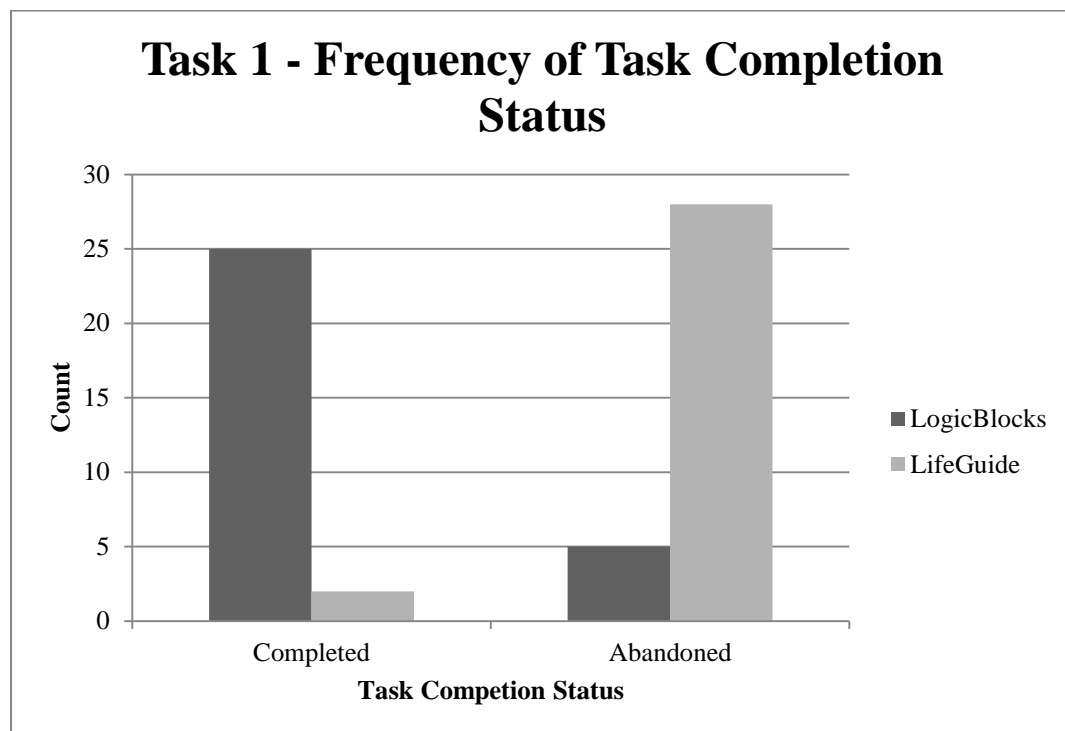


Figure 7.6: Task 1 – Frequency of Task Completion Status

Figure 7.6 presents a summary of the task completion status for Task 1, 83% of participants stated they felt they had successfully completed the task when using LogicBlocks and 6.67% utilising LifeGuide. The completion status for both interfaces produced significant results LogicBlocks ($\chi^2(1) = 13.333$, $p < 0.001$), LifeGuide ($\chi^2(1) = 22.533$, $p < 0.001$).

Participants were asked to think-aloud throughout the experiment, a subset of comments included:

“I’m just completely guessing” (LifeGuide, Participant 2)

“I would just give up; I’d be like come on.” (LifeGuide, Participant 12)

“The interface is much more user friendly and makes it easier to complete the task”

(LogicBlocks, Participant 19)

“Lots of support with shapes and feedback” (LogicBlocks, Participant 24)

Percentage Task Completion

Percentage task completion was measured by coding the participant’s logic output against a pre-specified coding schema (Table 7.6). A test-retest strategy was adopted with the participant order randomised. For reliability purposes and to avoid any potential bias there was no deviation from the marking allocation.

Step	Command	Variables	Order	Brackets	Quotes
Display Welcome	Show	Welcome	Show Welcome		
Display Consent	Show	Consent	Show Consent		
User Validation	AuthenticateUser	Welcome. UserId password	AuthenticateUser (,)	()	“”
Logic Condition	if	page and test	Show... if After...if...goto	If()	

Table 7.6: Task 1 Percentage Completion Coding Schema

Although not specified in the task description the correct command to be adopted in the validation of user credentials is the `authenticateuser` command. There are a number of other commands which provide alternative user management functions in LifeGuide such as `makenewuser`, `checkuserenabled` and `checkuserexists`. Although it could be viewed that participants successfully identified user commands, for the purpose of the experiment if any of these commands were used this was regarded as incorrect. Three participants selected the incorrect user function through the LogicBlocks interface (`makenewuser` and `checkuserenabled`) and 10 participants through the LifeGuide interface (`checkuserexists` and `checkuserenabled`). Interestingly due to the task description which included the word ‘check’ in the LifeGuide interface participants were looking for ‘check’ in the key commands pop-up menu.

Table 7.7 below presents the percentage task completion measure for both interfaces for Task 1. Percentages were calculated based on the coding schema presented (Table 7.6). Each successful criterion scored 4.7% the final 6% was calculated based on the order of logic for the 3 steps of the task description with 2% for each step.

	Task 1 Percentage Task Completion (%)	
	LogicBlocks	LifeGuide
N	30	30
Mean	78.88	58.38
SD	16.58	12.94
Significant?	Yes $p < 0.001$	

Table 7.7: Task 1 Percentage Completion

Table 7.7 shows that the average percentage task completion for Task 1 using the LogicBlocks interface was 35% higher than the LifeGuide interface, this is a significant result ($F(1, 29) = 32.392, p < 0.001$).

Discussion of Results

These results describe the usability measure of effectiveness by reporting on both participant reported and facilitator calculated task completion rates. 25 out of the 30 participants reported they had completed Task 1 through the LogicBlocks interface compared to only 2 participants feeling confident they had completed the task using the LifeGuide interface. Facilitator calculated scores reported mean percentage completion scores of 78.88% and 58.38% for the same task undertaken in LogicBlocks and LifeGuide respectively. Both measures of effectiveness support the hypothesis that interface type will have an effect on effectiveness relating to task completion; specifically that LogicBlocks will be more effective than the LifeGuide interface in a direct comparison experiment.

b. Measure of Efficiency

The efficiency reported outcome was measured based on the participant time to complete the task. Task duration was calculated from when the participant

confirmed their understanding of the task description and indicated they were ready to begin. The time recording was stopped when the participant specified they had completed or wished to abandon the task.

The research hypothesis relating to efficiency stated:

H₁: Utilising the LogicBlocks interface will result in reduced task completion time focusing on user management compared to the LifeGuide interface.

The null hypothesis:

H₀: proposes there will be no difference in duration of task completion between the LogicBlocks and LifeGuide interfaces in the creation of user management logic.

The average duration taken for Task 1 using LogicBlocks was 4 minutes 40 seconds compared to 6 minutes 25 seconds with the LifeGuide interface, this was significant ($F(1, 29) = 8.878, p = 0.006$). Table 7.8 summarizes the time taken with both interfaces measured in seconds. Participants spent 27% less time reaching the self-reported completion status for Task 1.

	Task 1 Total Time (secs)	
	LogicBlocks	LifeGuide
N	30	30
Mean	280.07	385.33
SD	114.43	180.10
Significant?	Yes p=0.006	

Table 7.8: Task 1 Duration

Participant comments relating to the efficiency measure included:

Much happier using this one I would be happier spending time using this than the last. Much more enjoyable would keep trying; think would get faster with use.

(LogicBlocks, Participant 8)

I could play around with it but it would absolutely take me forever, I'm not a play rounder (LifeGuide, Participant 3)

Discussion of results

The task duration results report on the time participants spent on Task 1 irrespective of their completion status. Covariate analysis found there was no interaction between task completion status and duration of time to complete the task. Some participants completed the task successfully in a short time-scale, others abandoned the task relatively quickly whereas others took longer and either successfully completed or abandoned the task. However effectiveness scores previously reported indicated both higher self-reported completion rates and percentage completion scores for the LogicBlocks interface in comparison with LifeGuide. This efficiency measure reports a 1 minute 45 seconds difference in mean to complete Task 1 between the two interfaces supporting the alternative hypothesis that task completion duration was less when adopting the LogicBlocks interface.

c. Measure of Engagement

The engagement measure was based on how pleasant the participants found using the interfaces and their self-reported satisfaction. The IBM After Scenario Questionnaire (Appendix 6) (Lewis, 1995) was utilised for this measure, where participants were asked to rate on a 7-point Likert scale the ease of completing the

task, satisfaction with the amount of time the task incurred and satisfaction with the support information. An overall satisfaction score was calculated based on a combined average of the three questions.

The hypothesis relating to engagement stated:

H₁: Participants self-reported satisfaction will be higher for the LogicBlocks interface focusing on the user management task compared to the LifeGuide interface.

The null hypothesis:

H₀: proposes there will be no difference in self-reported satisfaction between the LogicBlocks and LifeGuide interfaces in the creation of user management logic.

The results are summarised below in table 7.9. The LogicBlocks interface scored a 38% higher user satisfaction rating compared to the LifeGuide command line interface.

	Task 1 Satisfaction (1: Strongly Agree - 7: Strongly Disagree)	
	LogicBlocks	LifeGuide
N	30	30
Mean	3.1	5.04
SD	1.30	1.28
Significant?	Yes p<0.001	

Table 7.9: Task 1 Engagement Score

“I’d take the laptop down to show one of the programmers, so this is preventing me from doing this at home where I probably do most of my work” (LifeGuide, Participant 12)

“Made me feel dumb” (LifeGuide, Participant 2)

“No idea where to start, the logic wasn’t in the same order as mine” (LifeGuide, Participant 16)

“Found this difficult due to lack of experience with syntax” (LifeGuide, Participant 21)

“Much easier when coming cold to new syntax language” (LogicBlocks, Participant 6)

“Much happier with this one, much more confident” (LogicBlocks, Participant 8)

“The system is well designed and is very easy to use...Verified I hate text interfaces, I just don’t get them” (LogicBlocks, Participant 13)

“Very simple” (LogicBlocks, Participant 21)

“Familiar more visual think it would be easy to remember once done initially” (LogicBlocks, Participant 30)

“I wasn’t much better but I liked it” (LogicBlocks Participant, 18)

Discussion of results

The average user satisfaction ratings for both interfaces were 3.1 and 5.04 pertaining to LogicBlocks and LifeGuide respectively (Table 7.9). This is significant ($F(1, 29) = 62.826, p < 0.001$). A lower IBM After-Scenario score relates to a higher user

satisfaction outcome. The results presented support the alternative hypothesis that the LogicBlocks interface would score a higher level of satisfaction than the LifeGuide interface. Interestingly although a participant felt they had not performed the task any better through the LogicBlocks interface they still enjoyed using it.

d. Measure of Error Tolerability

The measure of error tolerability or error prevention relates to how well the interface prevents errors or assists in the recovery subsequent to an error occurring. Errors encountered and recovered from were observed throughout the experiment. Reported error counts were coded against the screen recordings based on the final logic produced on completion of the task or when the participant signaled they wished to abandon the task. Abandoned tasks were included because although some participants indicated they no longer wished to proceed the logic they had entered was in fact correct.

The hypothesis relating to error tolerability stated:

H₁: Lower numbers of errors will be experienced through the LogicBlocks interface focusing on user management compared to the LifeGuide interface.

The null hypothesis:

H₀: proposes the same number of errors will be encountered through both interfaces in the creation of user management logic.

The logic output from the task was coded to create a total error count. The count data was transformed using Aligned Rank Transform (ART) (Wobbrock *et al*, 2011) before analysis with repeated measures ANOVA. Total errors were calculated based

on the sum of error types including command; variable; order; bracket; quote and knowledge errors discussed further in section 7.6.2.6 Ancillary Analysis.

Table 7.10 below presents the summary data of the error counts for both LogicBlocks and LifeGuide, the result was found to be significant ($F(1, 29) = 16.259$ $p < 0.001$).

	Task 1 Number of Errors	
	LogicBlocks	LifeGuide
N	30	30
Mean	1.83	2.97
SD	1.177	1.520
Significant?	Yes $p < 0.001$	

Table 7.10: Task 1 Total Error Count

Discussion of Results

The mean reported error count for LifeGuide was 62% higher than the mean error count for the LogicBlocks interface supporting the alternative hypothesis that fewer errors will be generated through the LogicBlocks interface. Errors encountered in the LogicBlocks interface relating to duplication in displaying pages, blocks having empty sockets, and block nodes not being connected to complimentary receptors were quickly identified and resolved. Participants experienced difficulties with the error messages encountered through the LifeGuide interface, specifically due to the error description terminology:

“3 errors what, what the hell is r/n?...Don’t know what minimum parameters means” (Participant 2)

“Deleted brackets because of errors” (Participant 10)

“What’s eof?” (Participant 12)

“7 errors! I’ve only got 6 things in” (Participant 29)

e. Easy to Learn Measure

It can be difficult to place an actual quantifiable measure on the learnability outcome. Initial ease to learn was measured based on how often and for how long participants accessed the help manual, which as previously discussed provided consistent information across both interfaces. The follow up retention test (see section 7.6.2.4) also served to report on the ease to learn measure.

The ease to learn hypothesis was:

H₁: when interacting with the LogicBlocks interface in the creation of user management logic participants will access help less frequently and for less time than when utilising the LifeGuide interface.

The null hypothesis:

H₀: proposes there will be no difference in frequency or duration of help access between either interfaces in the creation of user management logic.

Table 7.11 below summaries the ease of learning outcome measure for Task 1. The average time spent in help (in seconds) relating to both interfaces is presented, alongside the average count of visits to the help guide. The statistical significance of the differences between the two interfaces is also presented.

	Task 1 Time in help (secs)		Help Count (Number of visits to help guide)	
	LogicBlocks	LifeGuide	LogicBlocks	LifeGuide
N	30	30	30	30
Mean	17.68	74.53	0.8	2.27
SD	31.43	77.38	1.532	2.840
Significant?	Yes p=0.004		Yes p=0.001	

Table 7.11: Task 1 Access to Help

Table 7.11 reports that on average, participants spent approximately 76% less time in help when using the LogicBlocks interface compared to the time spent in help with the LifeGuide interface. This is significant $\chi^2 (1) = 9.000$ $p=0.004$ employing a Friedman ANOVA. Interestingly when utilising the LogicBlocks interface 67% of participants did not access the Logic Dictionary at all, with 23% accessing help 1 or 2 times and the remaining 10% accessed help more than twice. Using the same comparison 23% of participants did not access help with the LifeGuide interface, 53% 1 or 2 times and 23% more than twice. This is a signification result ($F (1, 29) = 13.715$ $p = 0.001$), analysis was carried out using Aligned Rank Transform followed by repeated measures ANOVA.

Discussion of Results

On average participants spent 17.68 seconds and 74.53 seconds accessing the help manual provided with the LogicBlocks and LifeGuide interfaces respectively; thus supporting the alternative hypothesis. The same information was provided in both versions of the help manual where the only difference was blocks or textual code examples were provided. Participants reported in order to successfully use the help

manual prior knowledge of the system was assumed; specifically it was difficult to identify information regarding how to use a command if they did not know which command to use.

“I found it difficult to know what terms to search for in the help guide” (Participant 8)

“As is so often the case the help function, it assumes quite a lot of knowledge” (Participant 9)

“The help is set up based on you know the command and then tells you how to use it. So if you start with no knowledge you would have to scroll through lots of command until you hit upon the one you want” (Participant 20)

The feedback was more supportive for the LogicBlocks help manual, although the same content was presented.

“Help guide helped me in understanding it more” (Participant 13)

“Help in this section was much clearer” (Participant 25)

The LogicBlocks interface provided intrinsic help through the use of colours, jigsaw connectors and tool tips thus lowering cognitive load and reliance on memory.

“Lots of support with shapes and feedback” (Participant 24)

“I knew I needed a block with a curved slot” (Participant 18)

“Let’s match up the colour here I think I mean obviously I need this building block” (Participant 1)

“Oh no there’s a nub on it that didn’t make sense must be wrong” (Participant 2)

“I don’t think that’s right, that won’t go in there will it oh yes it does” (Participant 2)

“Less relying on memory” (Participant 1)

“That can’t be right because it isn’t the right balloon” (Participant 16)

“You’d need a box with 3 things wouldn’t you?” (Participant 27)

The use of colour in the help menu led to an issue where the screen contrast appeared different in the help menu compared with that of the LogicBlocks interface. The participant identified the colour of the block as brown in the help menu when it was actually orange which led to confusion when trying to locate the block. Also related to the use of colour the page interactions were located in the grey variable menu as ultimately this is the construct they represent, however the block was yellow to show it was part of the page object type.

As can be inferred from the participants’ comments above the jigsaw metaphor was found to be useful in indicating which blocks could be connected to each other. However there were two instances of the connectors failing in the design of *‘Knowledge in the head, knowledge in the world’*. One participant tried to connect a block with a ‘<’ connector to a receptor socket with a ‘(‘ connection type. The other issue related to the use of the ‘=’ block, the participant stated that if the block had adopted a vertical layout as opposed to the current horizontal layout she would have recognised it’s usage immediately.

Confirming the potential issues identified with using command line interfaces discussed in Chapter 6, participants experienced difficulties with the rigid syntax of the LifeGuide interface, specifically the correct use of brackets and quotes. LifeGuide also uses colour to indicate commands and key words, however this served as a source of confusion for this user group:

“The colours did not change for some words as expected” (Participant 14)

“It’s not right because it did not change colour, I’m guessing it has to change colour” (Participant 8)

“There we got it to turn blue, that’s something but it’s not right yet” (Participant 2)

“Assume is correct when blue” (Participant 2)

“I think it needs to be part of the command but when I put brackets in it doesn’t change colour” (Participant 14)

Participants often added brackets or quotes in order to change the colour of the text but lacking an understanding of the intended use.

f. Task 1 Summary

H₁: proposes that in a direct comparison task requiring the creation of logic to facilitate user validation and page display in the LifeGuide Authoring Tool, LogicBlocks will be more efficient, effective, engaging, error tolerant and easier to learn than the current command line interface provided by LifeGuide.

When broken down into individual measures based on the five Es of Usability each independent measure supported the alternative hypothesis – interface type will have

an effect. Specifically the Task 1 alternative hypothesis was supported in favour of the LogicBlocks graphical user interface. The results were based on a user management task with a complexity level of 4 commands, 3 variables, and 1 string interaction.

7.6.2.3. Task 2 – Dynamic Tailoring

Tailoring an intervention can result in higher levels of participant engagement. Task 2 (Appendices 12, 13) delivered a very basic but commonly required level of tailoring by requiring the creation of logic to customise which page is displayed to participants based on their selection from a range of voucher options.

The research hypothesis for the overall task:

H₁: proposes that in a direct comparison task requiring the creation of logic to facilitate tailored content and page display in the LifeGuide Authoring Tool, LogicBlocks will be more efficient, effective, engaging, error tolerant and easier to learn than the current command line interface provided by LifeGuide.

The null hypothesis:

H₀: proposes there will be no difference in efficiency, effectiveness, engagement, error tolerability and ease to learn in the creation of the logic required to facilitate tailored content and page display when comparing the use LogicBlocks to the current command line interface provided by the LifeGuide Authoring Tool.

All 30 participants completed Task 2 utilising the LifeGuide interface however only 26 participants carried out Task 2 with the LogicBlocks interface due to time constraints. The four participants who did not complete with both interfaces were

randomised to receive the LifeGuide interface first. Due to a corrupt screen recording, measurements for percentage task completion help duration, number of times help accessed, and error count could only be reported for 25 participants.

a. Measure of Effectiveness

Replicated methods for reporting accuracy and completeness of the task were adopted as per Task 1, participant reported task completion and percentage completion based on a coded task definition. Again participants were given no restriction on length of time to complete, and were reminded they could give up at any point.

The research hypothesis focusing on effectiveness was:

H₁: the LogicBlocks interface provides a more effective interface in the creation of intervention logic focused on dynamic tailoring than the LifeGuide command line interface.

The null hypothesis:

H₀: proposes there will be no difference in effectiveness between the LogicBlocks and LifeGuide interfaces in the application of dynamic tailoring logic.

Task Completion

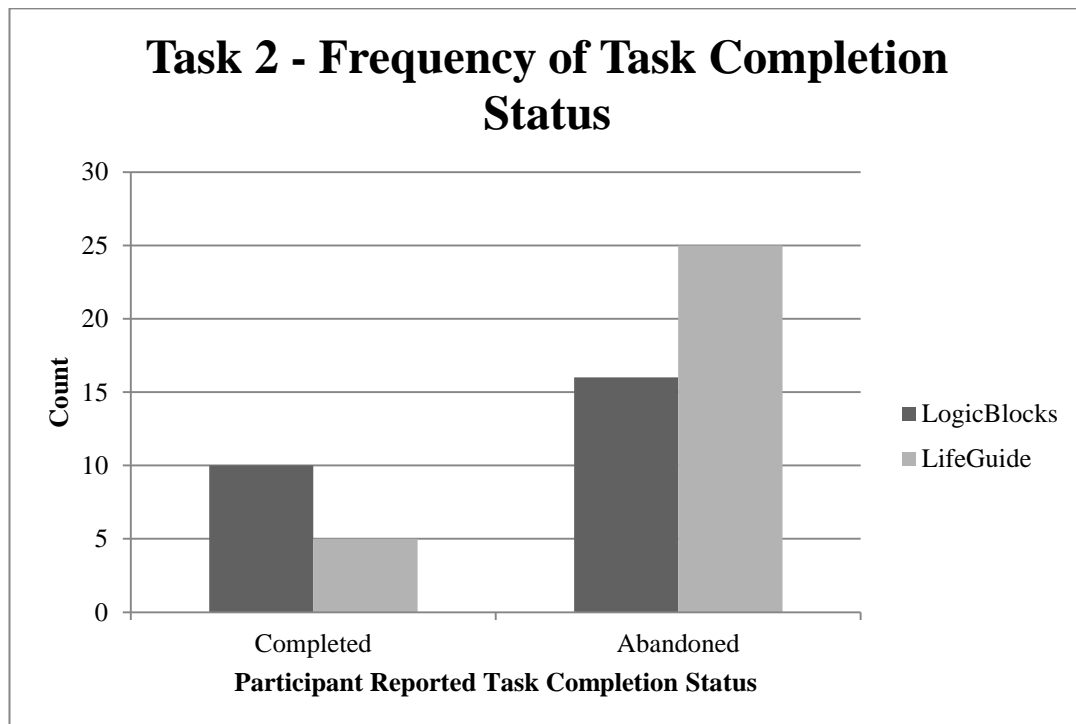


Figure 7.7: Task 2 – Frequency of Task Completion Status

50% more participants indicated completion of Task 2 using LogicBlocks compared to the LifeGuide interface. The completion status for the LifeGuide Interface produced a significant result ($\chi^2(1) = 13.333, p < 0.001$). The completion rate for the LogicBlocks interface was not significant ($\chi^2(1) = 1.385, p = 0.327$). Task 2 reported a higher rate of abandonment, only 38.46% of participants reported completion of Task 2 with the LogicBlocks interface and 16.67% through the LifeGuide interface. There was no significant difference between reported completion rates for Tasks 1 and 2 through the LifeGuide interface. The LogicBlocks interface however reported a significant difference between tasks ($\chi^2(1) = 11.065, p = 0.001$).

Participant comments included:

“Knew it was something simple and obvious but couldn't work it out!”(LogicBlocks Participant 31)

“There is a huge gap in expectations about what is expected of you and I would never have thought I’d be expected to do that” (LifeGuide, Participant 22)

Percentage Task Completion

Percentage task completion was similarly measured by coding the participant’s logic output against a pre-specified coding schema (Table 7.12). A test-retest strategy was adopted with the participant order randomised. For reliability purposes and to avoid any potential bias there was no deviation from the marking allocation.

Step	Command	Variables	Order	Brackets	Quotes
Display Voucher	Show	Voucher	Show Voucher		
Display Exit	Show	Exit	Show Exit		
Display Confirm	Show	Confirm	Show Confirm		
Logic Condition	if	Page and test	Show...if. After...if...go	()	
Dynamic Tailoring	=	Voucher. VoucherOptions Not Interested	Variable = String	()	
Dynamic Tailoring	= Not	Voucher.Vouch erOptions Not Interested, Amazon	Variable = String	()	""

Table 7.12: Task 2 Percentage Completion Coding Schema

Each of the thirty-five criteria (Table 7.12) was awarded a score of 2.69% with the addition of 2% for each of the 3 stages in the task description successfully completed in order.

	Task 2 Percentage Task Completion (%)	
	LogicBlocks	LifeGuide
N	25	30
Mean	47.07	39.4229
SD	28.70	26.10
Significant?	No $p=0.170$	

Table 7.13: Task 2 Percentage Completion

Table 7.13 reports an average percentage completion of 47% and 39% for the LogicBlocks and LifeGuide interfaces respectively. There was a 19% higher task completion rate with the LogicBlocks interface however this result is not significant ($F(1, 24) = 1.999, p = 0.170$).

Both interfaces reported significant percentage completion differences between Tasks 1 and 2, LogicBlocks reported 78.88% task completion in Task 1 compared with only 47.07% in Task 2 ($F(1, 24) = 32.087, p < 0.001$). The LifeGuide interface reported just under a 19% decrease in task completion between the two tasks ($F(1, 29) = 15.997, p < 0.001$).

Discussion of Results

Self-reported completeness was reported for all 30 participants utilising the LifeGuide interface but due to time restrictions only 26 participants attempted Task 2 with the LogicBlocks interface. Percentage completion scores for the LogicBlocks interface could only be reported for 25 participants due to a corrupt screen recording.

Lower rates of participant-reported completion were identified for the effectiveness rating of Task 2 compared to that of Task 1. The LifeGuide interface reported a significant difference between completed and abandoned attempts, whereas the result for the LogicBlocks interface was not significant. The LogicBlocks interface conveyed a higher percentage completion rate of 47% compared to 39% with the LifeGuide interface, however this was not found to be significant.

Unsurprisingly there was a difference in percentage task completion between Tasks 1 and 2 for both interfaces. The task complexity was increased with Task 2 requiring a greater usage of commands.

b. Measure of Efficiency

Time to complete task was again used as the measure to report efficiency of the interface.

The research hypothesis relating to efficiency stated:

H₁: Utilising the LogicBlocks interface will result in reduced task completion time focusing on dynamic tailoring compared to the LifeGuide interface.

The null hypothesis:

H₀: proposes there will be no difference in duration of task completion between the LogicBlocks and LifeGuide interfaces in the creation of dynamic tailoring logic.

On average participants spent 3% longer completing the task using the LogicBlocks interface compared with the LifeGuide interface (Table 7.14). Task duration for the

LogicBlocks interface was recorded as 8.03 minutes compared to 7.83 minutes for the LifeGuide interface this was not significant ($F(1, 25) = 0.442, p = 0.512$)

	Task 2 Total Time (secs)	
	LogicBlocks	LifeGuide
N	26	30
Mean	481.7692	469.9333
SD	197.211	226.62
Significant?	No $p=0.512$	

Table 7.14: Task 2 Duration

There was a significant interaction between order of interface and duration of time spent on the task. Participants spent longer on the task for the interface they were allocated first. ($F(1, 24) = 6.491, p = 0.018$).

Task had a significant effect on duration of time to complete for the LogicBlocks interface ($F(1, 25) = 22.490, p < 0.001$) but not for the LifeGuide interface ($F(1, 29) = 2.470, p = 0.127$).

Discussion of Results

Reported task completion times were longer for both interfaces compared to Task 1. Although not significant the average task duration for participants utilising the LogicBlocks interface was 3% longer than with the LifeGuide supporting the null hypothesis. Covariate analysis found no interaction between task duration and task completion status.

c. Measure of Engagement

Identical to the measure of engagement in Task 1 the IBM After-Scenario Questionnaire was employed to report participant satisfaction.

The hypothesis relating to engagement stated:

H₁: Participants self-reported satisfaction will be higher for the LogicBlocks interface focusing on the dynamic tailoring task compared to the LifeGuide interface.

The null hypothesis:

H₀: proposes there will be no difference in self-reported satisfaction between the LogicBlocks and LifeGuide interfaces in the creation of dynamic tailoring logic.

The overall satisfaction score was calculated based on ratings for ease of task, opinion on time to complete the task and supporting material. The LogicBlocks interface received an average engagement score of 3.8, 29% higher than the LifeGuide interface which scored an average score of 5.3. This was a significant results ($F(1, 25) = 21.986, p < 0.001$) (Table 7.15)

	Task 2 Satisfaction (1: Strongly Agree - 7: Strongly Disagree)	
	LogicBlocks	LifeGuide
N	26	30
Mean	3.7685	5.322
SD	1.27	1.37
Significant?	Yes $p < 0.001$	

Table 7.15: Task 2 Engagement Score

The average satisfaction score decreased between Tasks 1 and 2 for the LogicBlocks interface from 3.2 to 3.8 ($F(1, 25) = 7.416$ $p < 0.12$) the satisfaction rating for LifeGuide also decreased however not significantly ($F(1, 29) = 2.481$ $p = 0.126$).

Discussion of Results

Although the participant reported satisfaction score decreased slightly between Tasks 1 and 2 the alternative hypothesis that LogicBlocks would report a higher level of satisfaction than the LifeGuide interface was still supported.

Participant satisfaction feedback included:

“You see to me this feels like programming and this does not help the lady on the street, this is math’s, this is algebra, this is ah” (LifeGuide, Participant 22)

“I’m really sorry I’m finding this so hard, I’m ashamed” (LifeGuide, Participant 24)

“It looks friendly so I think I shouldn’t need help” (LogicBlocks, Participant 2)

“It’s like doing a horrible jigsaw; I don’t think I’m a programmer” (LogicBlocks, Participant 31)

“Is this how you write all LifeGuide code, it’s crazy, no wonder Survey Monkey is so popular” (Participant 2)

d. Measure of Error Tolerability

Again the error count was determined from the screen recording based on the participant signaling task completion/abandonment.

The hypothesis relating to error tolerability stated:

H_1 : *Lower number of errors will be experienced through the LogicBlocks interface focusing on dynamic tailoring compared to the LifeGuide interface.*

The null hypothesis:

H_0 : *proposes there will be no difference in the number of errors encountered between both interfaces in the creation of dynamic tailoring logic.*

On average 53% less errors were made using LogicBlocks than LifeGuide; this was significant ($F(1, 24) = 24.451$ $p < 0.001$)

	Task 2 Number of Errors	
	LogicBlocks	LifeGuide
N	26	30
Mean	2.60	5.47
SD	1.582	2.403
Significant?	Yes $p < 0.001$	

Table 7.16: Task 2 Error Count

Discussion of Results

The total number of errors encountered using both interfaces increased between the two tasks; however the error count for the LogicBlocks interface was significantly less than the LifeGuide interface thus supporting the alternative hypothesis. Significantly more errors were reported through the LifeGuide interface between Tasks 1 and 2 ($\chi^2(1) = 13.370$ $p < 0.001$), although the average number of errors was also greater for the LogicBlocks interface this result was not significant ($F(1, 24) = 2.985$ $p = 0.097$).

e. Easy to Learn Measure

Initial learning was measured relating to how often and for how long participants accessed the help menu. Deepening levels of learning were measured through the retention test (Section 7.6.2.4).

The ease to learn hypothesis was:

H₁: when interacting with the LogicBlocks interface in the creation of dynamic tailoring logic participants will access help less frequently and for less time than when utilising the LifeGuide interface.

The null hypothesis:

H₀: proposes there will be no difference in frequency or duration of help access between either interfaces in the creation of user management logic.

	Task 2 Time in Help (secs)		Help Count (Number of visits to help guide)	
	LogicBlocks	LifeGuide	LogicBlocks	LifeGuide
N	26	30	30	30
Mean	43.3712	85.7667	0.92	1.8
SD	51.87885	87.95385	1.197	2.007
Significant?	No p=0.189		Yes p=0.012	

Table 7.17: Task 2 Access to Help

Table 7.17 reports that on average, participants spent approximately 49% less time in help when using the LogicBlocks interface, this was not significant ($\chi^2(1) = 2.333$, $p = 0.189$) employing a Friedman ANOVA. Interestingly 46% of participants did not access the Logic Dictionary when completing the task using the LogicBlocks

interface, with 42% accessing help 1 or 2 times and the remaining 12% accessed help more than twice with a maximum of 4 visits. Using the same comparison 27% of participants did not access help with the LifeGuide interface with 50% accessing 1 or 2 times and 23% more than twice with a maximum of 8 visits. This is a significant result ($F(1, 25) = 3.489$ $p=0.012$), analysis was carried out using Aligned Rank Transform then repeated measures ANOVA.

Discussion of Results

There was no significant difference between the number of times or duration of help access between Tasks 1 and 2 for either interface, ($\chi^2(1) = 2.882$ $p=0.791$), ($\chi^2(1) = 2.882$ $p=0.143$ LogicBlocks, ($\chi^2(1) = 0.474$ $p=0.648$), ($\chi^2(1) = 0.0410$ $p = 1$) LifeGuide. The number of times help was accessed was less for the LogicBlocks interface compared to LifeGuide supporting the alternative hypothesis, however although the average duration of access was less for LogicBlocks than LifeGuide this was not significant supporting the null hypothesis.

f. Task 2 Summary

H₁: proposes that in a direct comparison task requiring the creation of logic to facilitate tailored content and page display in the LifeGuide Authoring Tool, LogicBlocks will be more efficient, effective, engaging, error tolerant and easier to learn than the current command line interface provided by LifeGuide.

The null hypothesis:

H₀: proposes there will be no difference in efficiency, effectiveness, engagement, error tolerability and ease to learn in the creation of the logic required to facilitate

tailored content and page display when comparing the use LogicBlocks to the current command line interface provided by the LifeGuide Authoring Tool.

Both user engagement and error tolerance measures significantly supported the alternative hypothesis. Participant reported task completion also supported the alternative effectiveness measure that LogicBlocks would be more effective than LifeGuide. Although the percentage completion scores remained higher for LogicBlocks this was not significant therefore supporting the null hypothesis. Similarly the number of times help was accessed was significantly less for the LogicBlocks interface than LifeGuide; the duration of time spent in help was also less for LogicBlocks however this was not significant. The measure of efficiency was based on duration of time to complete the task, for this task participants spent on average 3% longer with the LogicBlocks interface, there was not a significant difference consequently following the null hypothesis for efficiency.

7.3.2.4. Supplementary Learnability Measure - Retention Test

The target user group described will typically be accessing the software on an infrequent basis. Due to this infrequent access the interface must be intuitive and usage easy to remember. The ease of learning measurement also contains an aspect of retainability. Six weeks post-completion of the initial evaluation session six participants completed a retention task (Appendices 14, 15) which combined another user management function in the creation of a new user with the added functionality of sending an email. The task complexity lay in between Tasks 1 and 2 described earlier in the chapter. Three participants had prior programming experience and three were novice users. Apart from the task description participants were not provided with any more instruction or information simulating the ‘Walk-up-and-use’

approach. Due to the small sample size for this task only descriptive results are presented. The experiment collected the usability measures effectiveness, efficiency and error tolerability in combination with interface learnability, the hypothesis was:

H₁: in a direct comparison retention task requiring the creation of logic to facilitate user creation and email functionality in the LifeGuide Authoring Tool, LogicBlocks will be more efficient, effective and error tolerant due to ease of learning than the current command line interface provided by LifeGuide.

The null hypothesis:

H₀: proposes there will be no difference in efficiency, effectiveness and error tolerability due to ease of learning in the creation of the logic required to facilitate user creation and email functionality when comparing the use LogicBlocks to the current command line interface provided by the LifeGuide Authoring Tool.

Participants were randomised to complete the task using the LogicBlocks or LifeGuide interface, again participant allocation was based on participant availability consequently receiving the next block allocation in a pre-allocated randomisation list. The sample was formed of 2 males and 4 females, 5 participants were in the 21-30 age bracket and 1 was in the 51-60 age bracket.

All three participants allocated to the LifeGuide interface abandoned the task, one of which did not attempt the task at all (Participant 8) as she could not remember what to do.

“I wish I paid more attention the last time....cause I’m not using it every day how am I supposed to type in what to say.....is anyone else as useless as me” (Participant 8).

a. Retention Task Results

In support of the effectiveness measure a coding schema (Table 7.18) was created based on the task description.

Step	Command	Variables	Order	Brackets	Quotes
Display CreateUser	Show	CreateUser	Show CreateUser		
Display Confirmation	Show	Confirmation	Show Confirmation		
Create User	MakeNew User	UserID Password	MakeNewUser ID Password	()	
Send Email	SendEmail	Confirmation Email Registration Successful Email components	SendEmail id to subject content when	()	“”

Table 7.18: Retention Task Percentage Completion Coding Schema

For each criterion completed 4.6% was awarded with a further 2% for each of the 4 steps in the task description. The average task completion for the LifeGuide interface was 27.67% over a duration of 7.68 minutes with an average of 3 errors made. The LogicBlocks interface average percentage completion score was just under 3 times higher at 82.67% but over a longer duration of 8.8 minutes with an average of 2.67 errors (Table 7.19).

	Task Completion (%)		Task Duration (secs)		Number of Errors	
	LB	LG	LB	LG	LB	LG
N	3	3	3	3	3	2
Mean	82.6667	27.667	530.667	460.667	2.667	3
SD	12.50653	41.18657	80.829	324.05144	1.15470	2.828

LB: LogicBlocks, LG: LifeGuide

Table 7.19: Retention Task Completion, Duration and Error Count

The duration of time spent accessing the help manual and number of accesses was roughly the same for both interfaces with 33 seconds during 1.67 views for LogicBlocks compared to 30.6 seconds over an average of 1 viewing for LifeGuide (Table 7.20).

	Time in Help (secs)		Number of Time in Help	
	LogicBlocks	LifeGuide	LogicBlocks	LifeGuide
N	3	3	3	2
Mean	33.08	30.625	1.67	1
SD	57.30	43.31	2.887	1.414

Table 7.20: Retention Task Access to Help

b. Retention Task Summary

The number of errors encountered, duration of time spent in help and number of help accesses were fairly similar across both interfaces supporting the null hypothesis that there would be no difference between interfaces. The task completion percentage was 3 times higher for the LogicBlocks interface compared to the LifeGuide interface supporting the alternative hypothesis. 100% of the LogicBlocks participants indicated they felt they had successfully completed the task compared to

none of the LifeGuide group; which could be related to the task duration scores. Although participants using the LogicBlocks interface took longer to complete they did not abandon the task.

Participants did not complete a satisfaction questionnaire for the retention task but feedback included:

“It took me a couple of minutes to remember where things were and exactly how it worked but once I got started going into the menus etc., it came back. It felt easier this time than it did the first time, I felt better about where I was going” (LogicBlocks, Participant 7)

“All I can do with this interface is copy and paste from the examples and update the fields; I’m relying on prior programming knowledge” (LifeGuide, Participant 10).

“It wasn’t as difficult as the last time, I just got the idea and there was intuition as I was doing it” (LogicBlocks, Participant 13)

“I didn’t even remember there were commands there...am I a great disappointment...I’m going to have to give up I think” (LifeGuide, Participant 22)

“I think if I’d used it sooner I would have remembered more. The helps quite useful it tells you everything you need to do” (LogicBlocks, Participant 30)

7.3.2.5. Supplementary Engagement Measure - Overall Satisfaction

Participants completed all tasks with one interface before repeating the same tasks with the other interface based on arm randomisation. In between interfaces and after

the final interface participants completed the IBM Computer System Usability Questionnaire (Appendix 7) (Lewis, 1995). The results report overall satisfaction with the interface supplementing the measure of engagement with a particular focus on overall satisfaction, system usefulness, information quality and interface quality.

The hypothesis relating to overall engagement stated:

H₁: Participants self-reported overall satisfaction, system usefulness, information quality and interface quality will be higher for the LogicBlocks interface compared to the LifeGuide interface.

The null hypothesis:

H₀: proposes there will be no difference in self-reported overall satisfaction, system usefulness, information quality and interface quality between the LogicBlocks and LifeGuide.

A sample of usability statements from the four sub sections overall satisfaction; system usefulness; information quality and interface quality are presented below alongside a subset of participant responses:

7.3.2.5.1. Overall Satisfaction:

Overall I am satisfied with how easy it is to use this system

“It’s a really nice interface, I like the jigsaw pieces and the fact you can see that if the pieces don’t fit together then you can’t use them” (LogicBlocks, Participant 8)

“It is easy to use once you have a feel for it. Visually too dark, but the connectors make sense and prompt you” (LogicBlocks, Participant 14)

“Very complicated for someone with a ‘non-tech’ mind. Even though I am confident in using SPSS Syntax and use HTML, I still found this difficult and would need some time to learn the language” (LifeGuide, Participant 2)

“Needs experience knowledge of syntax, formatting of commands as not intuitive and help file did not give clear instructions” (LifeGuide, Participant 23)

It is simple to use this system

“Left hand column needs better clarity re commands” (LogicBlocks, Participant 11)

“With knowledge of correct syntax yes” (LifeGuide, Participant 21)

7.3.2.5.2. System Usefulness:

I am able to complete my work quickly using this system

“The task can be completed faster than doing everything from scratch”
(LogicBlocks, Participant 13)

“If you became very familiar with it, it would be quick but it would take a long time to reach that stage” (LifeGuide, Participant 28)

It was easy to learn to use this system

“It took me longer than I thought. I think once you know how to perform a few tasks it becomes easier” (LogicBlocks, Participant 14)

“Need more training but think could get it with that” (LifeGuide, Participant 23)

7.3.2.5.3. Information Quality:

Whenever I make a mistake using the system I recover easily and quickly

“No errors seen” (LogicBlocks, Participant 9)

“I knew I was making an error all the system did was tell me what I already knew, I needed it to suggest ways to correct the error” (LifeGuide, Participant 20)

7.3.2.5.4. Interface Quality:

I like using this system

“Very friendly” (LogicBlocks, Participant 2)

“Yes, if I knew more about the structure of the commands that are required”
(LifeGuide, Participant 20)

7.3.2.5.5. Overall Satisfaction Results

The participant reported usability scores for all sections were significantly higher for the LogicBlocks interface compared to LifeGuide (Table 7.21).

	Overall Satisfaction		System Usefulness		Information Quality		Interface Quality	
	LB	LG	LB	LG	LB	LG	LB	LG
N	30	30	30	30	30	30	30	30
Mean	2.90	4.74	2.84	5.04	3.25	4.84	2.46	3.88
SD	0.97	1.33	1.02	1.51	1.16	1.324	1.01	1.4
Significant?	Yes $p < 0.001$		Yes $p < 0.001$		Yes $p < 0.001$		Yes $p < 0.001$	

Table 7.21: Overall Satisfaction

Overall Satisfaction ($F(1, 29) = 62.814$ $p < 0.001$), usefulness ($F(1, 29) = 74.996$ $p < 0.001$), information quality ($F(1, 29) = 42.003$ $p < 0.001$) and interface quality ($F(1, 29) = 17.964$ $p < 0.001$)

The lower the rating on the 7-point Likert scale represents a higher usability score. LogicBlocks was rated 39%, 44%, 33% and 37% higher than LifeGuide for overall satisfaction, system usefulness, information quality and interface quality respectively (Figure 7.8)

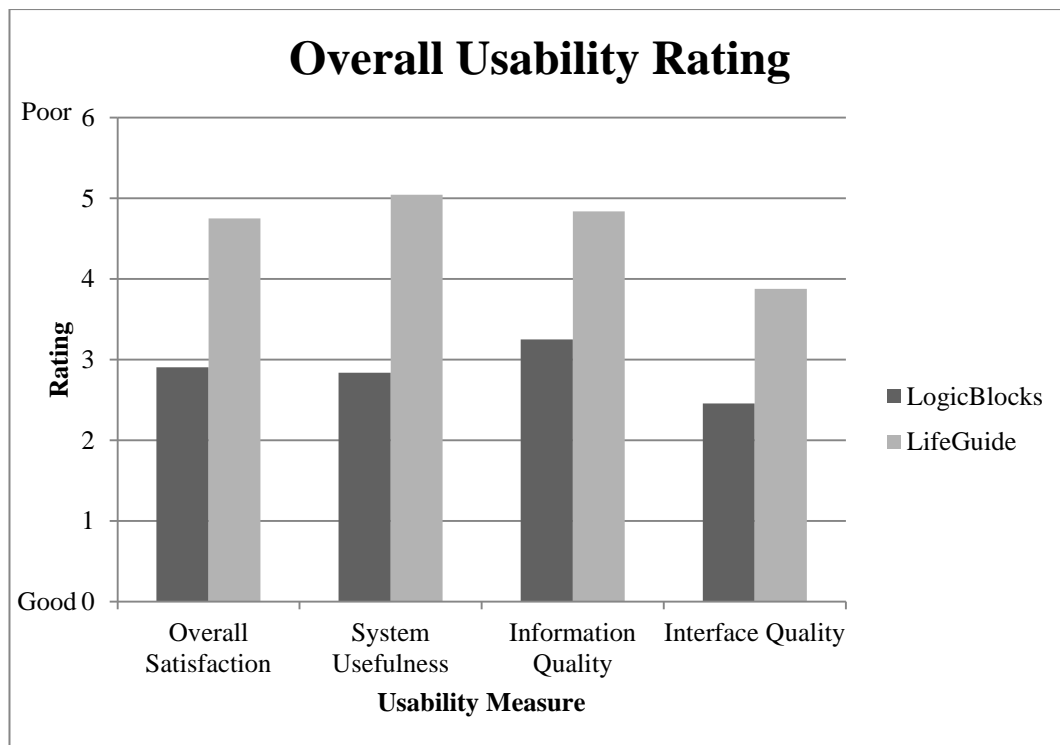


Figure 7.8: Overall Usability Rating

A debriefing session was conducted on completion of the experiment where participants were asked to provide general feedback on the interfaces concluding by stating their interface preference. Participants were reminded that they were not required to answer and could select either, neither or both interfaces. 27 out of 30 participants (Figure 7.9) preferred the LogicBlocks interface; this was statistically significant ($\chi^2(1) = 19.200$ $p < 0.001$).

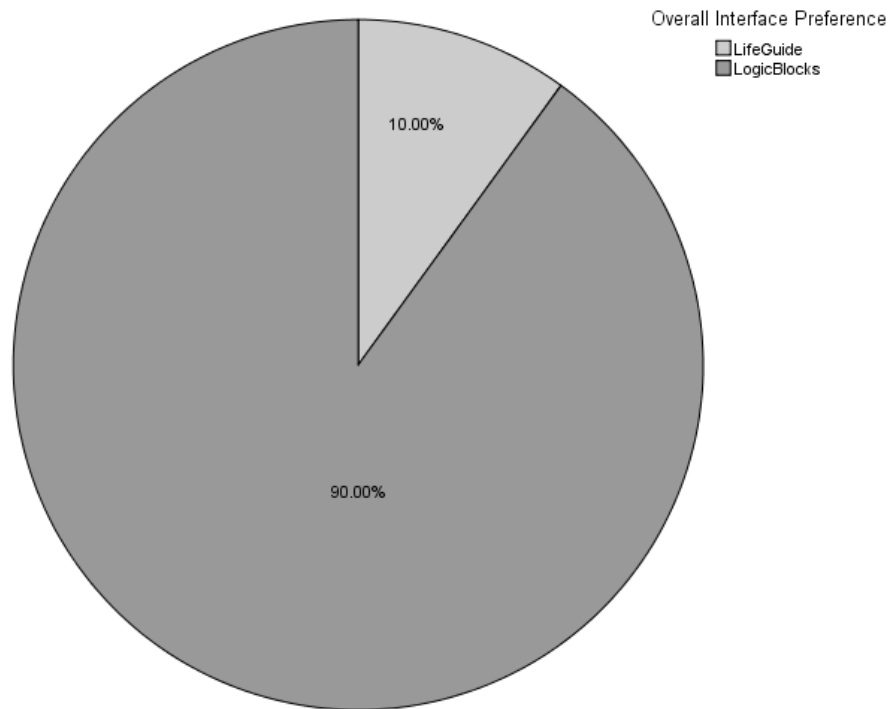


Figure 7.9: Overall Interface Preference

7.3.2.5.6. Overall Satisfaction Summary

The LogicBlocks interface received higher participant reported engagement scores over both tasks and for overall interface based on the IBM After-Scenario and After-Interface Questionnaires. Concentrating on the overall satisfaction score 90% of participants preferred the LogicBlocks interface with higher scores received across all 4 categories of the questionnaire supporting the alternative hypothesis that interface, specifically LogicBlocks will have an effect on user engagement.

7.3.2.6. Ancillary Analyses

Two secondary outcome measures were analyzed subsequent to the primary outcome measures with a quantitative focus on types of errors encountered and a qualitative emphasis on user interaction with the interfaces.

7.3.2.6.1. Error Types

Six main error types were identified in the creation of the logic by participants in both interfaces through an error coding exercise. Interestingly the errors encountered related to the issues previously identified as potential sources of errors for non-programmers – syntax and command usage:

- Command: incorrect command utilised based on the task description
- Variable: incorrect variable use
- Order: logic entered in the wrong order
- Brackets: incorrect use or missing parentheses
- Quotes: incorrect or inconsistent use of quotation marks
- Knowledge: errors due to lack of experience with the language such as knowing the `goto` command does not actually display a page, `show` is still required

The hypothesis relating to error type stated:

H₁: Lower numbers of command, variable, order, bracket, quote and knowledge errors will be experienced through the LogicBlocks compared to the LifeGuide interface.

The null hypothesis:

H₀: proposes the same number of command, variable, order, bracket, quote and knowledge errors will be encountered through both interfaces in the creation of logic.

Error Types - Task 1

Significantly fewer errors overall were encountered with the LogicBlocks interface compared to LifeGuide. Focusing on error type lower numbers of command, order, bracket and knowledge errors (Table 7.22) were reported for the LogicBlocks interface; ($F(1, 29) = 10.204$ $p = 0.003$), ($F(1, 29) = 4.645$ $p = 0.040$), ($F(1, 29) = 16.716$ $p < 0.001$) and ($F(1, 29) = 1.994$ $p = 0.169$) respectively. Although not significant, higher variable and quote errors were encountered with the LogicBlocks interface compared to the LifeGuide interface, ($F(1, 29) = 0.025$ $p = 0.875$) and ($F(1, 29) = 4.008$ $p = 0.055$).

	Command		Variable		Order	
	LB	LG	LB	LG	LB	LG
N	30	30	30	30	30	30
Mean	0.4	1.17	0.4	0.3	0.1	0.33
SD	0.5	0.95	0.77	0.54	0.40	0.55
Significant?	Yes p=0.003		No p=0.875		Yes p=0.040	

LB: LogicBlocks, LG: LifeGuide

	Quotes		Knowledge		Bracket	
	LB	LG	LB	LG	LB	LG
N	30	30	30	30	30	30
Mean	0.5	0.27	0.3	0.5	0	0.4
SD	0.63	0.52	0.60	0.63	0	0.56
Significant?	No p=0.055		No p=0.169		Yes p<0.001	

LB: LogicBlocks, LG: LifeGuide

Table 7.22: Task 1 Error Types

Error Types - Task 2

An overview of error types encountered in Task 2 is presented below (Table 7.23). Similarly Task 2 reported lower command, order, bracket, knowledge and additionally variable errors for the LogicBlocks interface compared to LifeGuide, ($F(1, 24) = 16.851$ $P < 0.001$), ($F(1, 27) = 5.342$ $p = 0.029$), ($F(1, 27) = 26.843$ $p < 0.000$), ($F(1, 24) = 3.811$ $p = 0.063$) and ($F(1, 27) = 1.718$ $p = 0.201$). Quote errors

were repeatedly higher although not significantly with the LogicBlocks interface ($F(1, 24) = 0.001$ $p = 0.974$).

	Command		Variable		Order	
	LB	LG	LB	LG	LB	LG
N	25	30	25	30	25	30
Mean	0.84	1.77	0.36	0.83	0.48	0.73
SD	1.21	1.14	0.49	1.34	0.87	0.94
Significant?	Yes $p < 0.001$		No $p=0.201$		Yes $p = 0.029$	

LB: LogicBlocks, LG: LifeGuide

	Quotes		Knowledge		Bracket	
	LB	LG	LB	LG	LB	LG
N	25	30	25	30	25	30
Mean	0.12	0.07	0.8	1.33	0	0.73
SD	0.44	0.25	1.00	1.06	0	0.91
Significant?	No $p=0.974$		No $p=0.063$		Yes $p<0.001$	

LB: LogicBlocks, LG: LifeGuide

Table 7.23: Task 2 Error Types

7.3.2.6.2. Error Types Summary

Chapter 6 identified possible barriers to learning to program for beginners, in particular due to strict syntax. The LogicBlocks interface incorporated templates and pre-populated fields in an aim to reduce errors for non-programmers. The hypothesis for this auxiliary analysis proposed that fewer command, variable, order,

bracket, quote and knowledge errors would be encountered through the LogicBlocks interface in direct comparison with LifeGuide.

The LogicBlocks interface was designed such that brackets are automatically included in the parsed command line output in the correct format, removing the requirement for users having to remember the strict syntactical usage. Unsurprisingly the LogicBlocks interface alleviated bracket errors with zero reported across both tasks compared to an average of 0.4 and 0.73 bracket errors with the LifeGuide interface. There were also fewer command, order and knowledge errors identified through the LogicBlocks interface supporting the alternative hypothesis. Although lower knowledge errors were reported they were not a significant result. A greater frequency of quote errors were reported over both tasks with the LogicBlocks interface and Task 1 reported higher rates of variable errors, neither of which were significant, therefore supporting the null hypothesis.

Task had a significant interaction on command and quote errors for the LifeGuide interface with an increase in error rates between tasks, ($\chi^2(1) = 6.368$ $p=0.019$) and ($\chi^2(1) = 8.048$ $p = 0.007$) respectively. There was also an increase in order and quote errors for the LogicBlocks interface between tasks, ($\chi^2(1) = 5.4444$ $p = 0.039$) and ($\chi^2(1) = 5.333$ $p=0.039$).

7.3.2.6.3. User Interaction

A coded qualitative thematic analysis relating to methods of interaction and functionality utilised was recorded against the screen recordings for both tasks and interfaces.

The main interaction style adopted for the LogicBlocks Graphical User Interface involved participants selecting commands from the menu groups; to delete commands in the majority of cases the blocks were dragged to the bin metaphor at the bottom of the screen. Participants also exploited the right-click menu in the deletion of blocks. The right-click menu was also employed to replicate blocks through the copy and paste functionality resulting in participants only having to change the page or variable. More confident users adopted to use the command short-key presses to create blocks, removing the requirement to access the menus. The successfulness of the search facility varied between users, confusion was encountered when participants tried to search for the page names rather than commands. The connection types were found to be intuitive and implicit by the majority of participants however as discussed one participant tried to join a '<' connector to a '('receptor, another participant also tried to join two '>' '<' connectors together. If participants were unsure which command they required they dragged all the potential blocks on to the logic panel supporting exploratory behaviour. Participants interacted with the LifeGuide interface by directly typing commands into the Command Line Interface. However it was noted that the majority of participants relied upon the command pop-up menu, making selections using the mouse. Participants were confused as the display of this menu was inconsistent. If errors exist in the logic the menu is not displayed, which led to participants adding brackets or quotes in order to display the menu. In the search for the relevant command participants tried to pick out keywords from the task description.

7.4. Limitations

The following limitations of the preceding evaluation are identified:

7.4.1. Evaluation Duration

It was thought that an hour session would be long enough to obtain the results required for the experiment whilst avoiding experiment fatigue and requiring too much of the participants time. However in practice for some participants this was not long enough, resulting in 5 participants failing to attempt take 2 for both interfaces.

7.4.2. Retention Sample

Only six participants completed the retention experiment therefore quantitative results cannot be reported.

7.4.3. Evaluation Tasks

The tasks were designed based on the fundamental functionality required of an Internet Intervention replicating the logic utilised in the '*real world*' study relating to prescribing discussed in Chapter 6. In order to deliver comparable results across the interfaces the task descriptions although open to participant interpretation were very prescriptive. A recommendation for future work would be to allow participants to create their own interventions with associated logic functionality.

7.4.4. Learning Effect

A within-group analysis was used in the experiment; in order to avoid potential learning effect the order of interface was randomised. It was observed that some participants remembered the commands between tasks. For similar experiments a delay between interface sessions would be recommended.

7.4.5. Task Completion

The participants indicated when they felt they had successfully completed the task. For most participants this was when there were no errors reported in the logic. However this did not always reflect the task had been completed successfully. A future recommendation would include pass or fail criteria to alert the participant if they had completed the task correctly.

7.4.6. Task Complexity

The design of the tasks was such that complexity increased with each subsequent task. The practice task served to confirm a basic understanding of how to interact with the interfaces and enter the most basic levels of logic. Task 1 increased in complexity through the usage of logic branching and user management functionality, Task 2 further increased complexity through multiple branching conditions and the use of the '=' and 'or' operators. Due to time restrictions only 26 out of the 30 participants completed Task 2 with both interfaces. The primary outcomes measures reported lower scores between tasks i.e. higher abandonment; lower task completion scores; longer task duration; decreased satisfaction and increased errors.

A greater decrease in the average percentage completion score was reported for LogicBlocks compared with that of LifeGuide 31.88% and 19% respectively however, 50% more participants completed the task with LogicBlocks with an average 47% completion score compared to 39% with LifeGuide.

Unsurprisingly the task completion times were greater for Task 2 reflecting the increased challenges relating to complexity. The average completion time for Task 1 was 1 minute less for LogicBlocks than with LifeGuide; however the average time for completion with LogicBlocks was 11 seconds longer in Task 2.

Both interfaces reported decreased satisfaction scores between tasks however LogicBlocks reported significantly lower satisfaction scores across both tasks further supported by participant feedback and after interface questionnaires. LogicBlocks reported satisfaction scores of less than 4 across both tasks whereas the LifeGuide interface scored above 5 for both tasks.

As the task complexity increased the number of errors encountered also increased for both interfaces, although LogicBlocks reported significantly less errors across both tasks. There was an increase of 0.77 on the average number of errors between tasks for LogicBlocks this was not significant. The average number of errors with the LifeGuide interface significantly increased by 2.5 between Task 1 and Task 2.

The ease of learning measurement focusing on access and duration of access to help reported no task interaction. Frequency of access and duration of access to help was lower across both tasks for LogicBlocks compared with LifeGuide.

The evaluation duration was identified as a limitation earlier in this section; participants had to absorb multiple concepts within a limited timeframe. Although the task complexity increased between tasks 1 and 2, the lower scores may also be attributed to experiment fatigue. It is assumed that with more usage these scores would improve for both interfaces however further investigation into task complexity effect is recommended.

7.5. Generalizability

The LifeGuide Authoring Tool was designed to reduce the reliance of healthcare researchers on professional software engineers in the development of behaviour change interventions. The LogicBlocks interface was developed focusing on user-centred design techniques to alleviate the potential barriers to logic creation in a command line interface such as syntax errors and cognitive load due to remembering commands.

A thematic analysis of semi-structured interviews with LifeGuide users carried out by the developers of the LifeGuide Authoring Tool (Williams *et al*, 2013) supported the overarching theme that programming issues are of high concern with this user group. The results highlighted that users are required to learn new skills in order to

create intervention logic in LifeGuide and in complex cases require the involvement of a software engineer.

“I can’t program...I’ve never been a programmer and although the terms we’re using are easier, the concept of programming is still part of LifeGuide” (P1)

“I think it was a bit stressful as well again because you...you’re not [a] programmer.” (P13)

Issues with the strict syntax, remembering commands and confusing error messages were also identified by the author in the facilitation of a Continuing Professional Development Workshop on LifeGuide with the Health Psychology Group at the University of Aberdeen. Unfortunately due to time restrictions the LogicBlocks interface could not be incorporated into the session. The workshop involved participants creating basic interventions and associated logic based on tutorials available through the LifeGuide Community Forum. Frequent sources of error were attributed to brackets, quotation and command inexperience.

The LifeGuide evaluation and workshop findings support the requirement of an alternative interface for non-programmers in the creation of logic in the LifeGuide Authoring Tool.

7.6. Interpretation

The experiment hypothesis was:

“LogicBlocks will increase user satisfaction, learnability, the task completion rate, reduce errors, task completion time and duration of access to support documentation when creating Internet Interventions compared to the current command line interface provided by the LifeGuide Authoring Tool”.

The hypothesis is defined by 5 primary quantifiable measures which in combination describe the usability of both interfaces. The qualitative usability of the interfaces was further supported through the participants’ feedback, free text comments and session debriefing.

The results from Task 1 supported the hypothesis for all primary outcome measures in favour of the LogicBlocks interface. Task 2 also supported the task completion rate, user satisfaction score, learnability, error reduction rate and duration of access to support documentation in favour of the LogicBlocks interface but only significantly for the satisfaction and error reduction measures. Covariate analysis of the results found no significant interaction between the primary outcome measures. The statement that LogicBlocks would increase learnability compared to LifeGuide was also further supported through a descriptive retention task where participants randomised to the LogicBlocks interface reported an average 82.7% percentage completion score compared to 27.5% in the LifeGuide group. All three participants in the LifeGuide group abandoned the retention task.

7.7. Observations

7.7.1. Previous Programming Experience

The baseline questionnaire was specifically designed to obtain participants previous programming experience and self-reported level of expertise. There was an expectation that users with previous experience may perform better with the standard LifeGuide interface than those participants without programming experience. 6 of the participants program on average, on a weekly basis. Ancillary covariate analysis reported there was no interaction between previous programming experience and any of the five primary outcomes measures of efficiency; error tolerability; effectiveness; engagement and ease of learning. Interestingly highlighted through observation these participants attempted to utilise '*knowledge in the head*' by adopting syntax, formatting and commands which they were familiar with from other command line languages. This previous knowledge assisted in the use of parenthesis formatting; however it also led to error generation where the LifeGuide commands and formatting differed from that of languages such as Java or C#. This was particularly evident in the ordering of commands in the branching logic tasks.

7.7.2. Abandonment

The design of the experiment attempted to simulate a '*walk-up-and-use*' metaphor, participants were reminded at the start of the evaluation that they could and should abandon the task as they would in 'real-world' usage. Covariate analysis reported there was no interaction between task completion status and percentage task completion score; thus data for these participants was analysed identically to those

participants who felt they had completed the task successfully. As discussed in the limitation section above the abandonment measure was participant reported which resulted in participants feeling they had not completed the task successfully when in fact the logic they had entered was correct. 28 participants abandoned Task 1 with the LifeGuide interface and 5 participants with the LogicBlocks interface, this initial first impression of the interface could in 'real-world' usage result in users disregarding the tool and looking for an alternative package in the creation of Internet Interventions.

7.8. Funding

This study was funded by the Chief Scientists Office (CSO) (CZH/4/610) specifically the software development of LogicBlocks and participant remuneration in the form of gift vouchers. CSO awarded the end of project report as Excellent.

7.9. Summary

This chapter presents the findings of a comparative summative evaluation of the LifeGuide command line interface versus the LogicBlocks graphical user interface developed in Chapter 6. The results from the task-based experiment are reported with primary outcome measures focusing on the five E's of usability effectiveness; efficiency; engagement; error tolerability and ease of learning. Two tasks were described which simulated two of the most common functionality required in an Internet Intervention. A follow up retention experiment was also presented with a view on measuring learnability.

The results describe that over both tasks the LogicBlocks interface reported higher effectiveness, engagement, error tolerance and ease of use. The measure of efficiency was significantly higher for the LogicBlocks interface for Task 1 but lower for Task 2 although not significantly. All outcome measures for both interfaces decreased between tasks.

User-centred design with early and continuous involvement based on principles of interface design were adopted in the development of the LogicBlocks interface (Chapter 6). This was successfully supported by the participants' feedback:

"Better for memory aid if coming back to it after months...graphical one is a lot easier, it's nice as well" (Participant 4)

"Would tinker with blocks, you can see what's there and errors make sense, could use GUI infrequently" (Participant 5)

"Graphics remove the number of errors you can make so less chance of making a mistake... Like a jigsaw so your building a big jigsaw, excited by this...ooh I like that" (Participant 8)

"The graphical interface is much more intuitive to me, it's much simpler, partly it's the visual thing, it's easy to see straight away if you're missing something...I wouldn't have trouble with the textual one as long as I had time to learn it" (Participant 9)

"Prefer graphics, I like colours, I like jigsaws" (Participant 23)

Consideration to the infrequent usage of the tool was taken into account in the design of the LogicBlocks interface. The retention results describe an average higher percentage completion score for the LogicBlocks interface.

The LifeGuide development team acknowledged the limitations of the interface for the target population which was further supported through a Continuing Professional Development workshop completed by potential users.

Chapter 8 Conclusions and Recommendations for Future Work

The research reported in this thesis explores the hypothesis that:

The provision of a usable software tool designed adopting user-centred design techniques can reduce the reliance of healthcare researchers on professional software developers in the creation of Internet Interventions.

The main findings are summarised below:

8.1. Summary

8.1.1. Internet Interventions – Current Practice

The Internet provides an accessible platform to support the provision of healthcare interventions. Healthcare interventions focus on the promotion of good behaviours; prevention of bad behaviours; provision of support for shared decision making; increasing knowledge and improving monitoring. The Internet allows for technology enhancements such as multimedia components and dynamic tailoring which aid user engagement which is particularly applicable for longitudinal studies. The Internet also supports anonymity; a desirable feature for interventions relating to sensitive healthcare topics.

Healthcare interventions aim to support treatment decisions; increase knowledge; change behaviour or model an experiment prior to a full trial. Typically such

interventions are developed by professional software developers as part of a multi-disciplinary team. The development of three such interventions relating to different healthcare topics identified common features shared by Internet interventions independent of their purpose. Each of the interventions developed included multimedia components; navigation; user response capture; logic in the control of the intervention; data storage; user management and logging. The collective term Internet Intervention was adopted to represent any healthcare intervention delivered via a web-based platform.

8.1.2. Development of an Internet Intervention Creation Tool

There was an immediate lack of a tool to facilitate the creation of Internet Interventions by healthcare researchers who are typically infrequent users with no prior programming experience.

A prototype intervention creation tool was developed based on the functionality required in a study focused on lowering inappropriate x-ray referrals. The development followed user-centred design techniques with early and continuous user involvement, a rapid prototyping methodology and frequent user evaluations. While identifying a possible funding source to transform the prototype into a fully functional solution an alternative solution in the form of the LifeGuide Authoring Tool was identified.

LifeGuide was successfully employed in over 170 live trials by June 2014 with nearly 1700 users signed up to the community website. The tool provided the

functionality identified as requirements of a typical Internet Intervention including multimedia components and response capture. Logic is required at a minimum level to display pages in order, more complex logic is required to allow for functionality such as user management, dynamic tailoring and randomisation. Users are required to enter the logic commands through a command line interface following strict syntax. Heuristic evaluations identified this interface as a potential barrier to adopting LifeGuide for the target user group.

To alleviate this obstacle for infrequent users or non-programmers a Graphical User Interface (GUI) entitled LogicBlocks was developed as an alternative to the current LifeGuide command line interface. Again a user-centred design approach was adopted with an iterative cycle of prototyping including an initial paper prototype. Based on the principles of interface design a jigsaw metaphor was adopted. Colours; grouping; pre-populated fields and templates were utilised with the aim of reducing potential syntax errors and lowering the cognitive load incurred with having to remember the logic commands. Tool-tips and label reminders were incorporated to provide support for infrequent users.

8.1.3. Evaluation of a Graphical User Interface to Intervention Logic

The aim of the LogicBlocks GUI was to remove the potential obstacles faced by non-programmers in the creation of intervention logic through the LifeGuide command line interface. A summative task-based evaluation was carried out with a focus on the five main usability measures: effectiveness; efficiency; engagement; error tolerability and ease of learning. A within-group analysis of thirty participants

compared both interventions in the creation of commonly used logic focused on user management and dynamic tailoring. The LogicBlocks interface reported significantly higher results for all primary usability measures for Task 1 and the engagement and error tolerability measure in Task 2. Although LogicBlocks reported higher effectiveness and ease of learning scores for Task 2 the results were not significant. The LifeGuide interface reported on average a lower task duration time in Task 2, however this was not found to be significant. Significantly twenty-seven out of the thirty participants preferred the LogicBlocks interface which highlights the possible benefits of adopting user-centred design principles and user involvement throughout the design process. A sub-study retention task, 6 weeks post experiment was completed with a focus on learnability and retainability of the interface. A between-group design was adopted where six participants were randomised to complete the task with either the LogicBlocks or LifeGuide interface. The average task completion score for the LogicBlocks interface was 82.7% compared to only 27.7% for the LifeGuide interface. All three participants allocated to LifeGuide abandoned the task. The results of the retention task are particularly pertinent for this target user group whose usage previously defined in Chapter 3 is typically during an intense period but on an infrequent basis. Learnability is an extremely desirable feature in the design of a tool for this user group. The results suggest the design of the LogicBlocks interface supports intermittent usage.

Through the LifeGuide Authoring Tool healthcare researchers can use similar skills as required of a standard word processing application to create Internet Interventions without the previous reliance on professional software developers. Augmenting LifeGuide with the LogicBlocks interface has the potential to reduce the barrier to

logic creation currently imposed by the LifeGuide command line interface. Although the LogicBlocks interface requires improvement based on the evaluation feedback; participants reported with more exposure their effectiveness and efficiency would be improved, they felt confident they would be able to use the interface infrequently and the interface was very intuitive and user-friendly.

The evaluation served to demonstrate that within a short period of time participants with no previous exposure or programming experience could utilise the most commonly used logic commands. The LogicBlocks interface reported higher usability and preference to LifeGuide and most importantly for this user group reduced the initial perceived barrier to logic generation and supported infrequent usage. The LifeGuide Authoring Tool in combination with LogicBlocks provides the functionality required to develop the five case studies presented throughout the thesis in addition to a further 6 interventions developed by the author. If the research teams had access to such a tool, the involvement of a professional software developer could have been reduced if not removed from the project. LifeGuide is not applicable for two interventions developed by the author as they were required to be embedded within NHS systems with linked access to patient medical records.

8.1.4. Potential Alternative Solutions

Since the development of LogicBlocks, in keeping with current technology advancements alternative potential tools have been developed. Microsoft Project Siena and MIT App Inventor are tools which aim to facilitate the creation of applications (apps) by users with no previous programming experience. These packages however are platform dependent; Project Siena is a Windows based

solution and App Inventor can be adopted in the development of Android applications. These potential restrictions in accessibility need to be considered in the development of application based healthcare interventions.

8.2. Enhancements to the Graphical User Interface

8.2.1. Beta Prototype

Based on discussions with the LifeGuide group at the University of Southampton the next stage in the development of LogicBlocks is to increase exposure to the interface by offering it as a beta prototype for download through the LifeGuide community website. A final prototype will subsequently be available following the addition of any feedback from the beta prototype.

Prior to beta release the following enhancements were identified through the interface evaluation:

- Command Menus/Groupings

The command groups were identified through card sorting and further confirmed by twelve members of the project group. However difficulties were observed through the evaluation locating commands based on the menu labels.

- Colour Scheme

Participants indicated that higher contrasts in the colour of the groups would be beneficial. Changing the background colour of the logic pane to white instead of black will also be evaluated.

- Quotation Errors

The LogicBlocks interface reported higher quotation errors for both tasks compared with the LifeGuide interface. The design of text, variable and interaction blocks requires further attention to make the usage more apparent to users.

8.2.2 Dual Logic Interface

The current LogicBlocks prototype is currently a standalone tool with dual communication functionality to/from LifeGuide. The page names and interactions are automatically extracted from LifeGuide into LogicBlocks and the logic commands parsed from LogicBlocks are automatically imported into LifeGuide. Ultimately the graphical user interface will be an embedded option within the LifeGuide Authoring Tool. The most appropriate solution would provide a transparent two way flow between the graphical logic and textual command logic and vice-versa. The provision of both interfaces will allow LifeGuide to be accessible by users with varying experience levels. Parkes *et al* (2011) describe similar synchronized views in the translation of graphical flowcharts into pseudo code or command line programming. Dragicevic *et al* (2011) also adopts an interesting approach in the translation of HTML markup into its visual rendering.

8.2.3 Recommendations for LifeGuide Help Manual

Participants indicated the current LifeGuide help manual layout assumes prior knowledge of the commands available. A recommendation would be to group the commands by the task they perform i.e. group all user management commands together. The LogicBlocks help manual would benefit from copy and paste

functionality to allow users to directly copy from the help manual directly into LogicBlocks.

8.3. Limitations

8.3.1. Intervention Design

The LifeGuide Authoring Tool augmented with LogicBlocks has the potential to further reduce the reliance of healthcare researchers on professional software developers in the creation of Internet Interventions. However software developers also have skills and knowledge in the creation of usable interventions focusing on interface design principles. These skills healthcare researchers may lack. The provision of page templates, design tips and incorporation of style sheets can help to prevent the creation of ineffective interventions due to badly designed interfaces.

8.3.2. Logic Complexity

The LogicBlocks interface was designed to support the knowledge deficit and relearning associated with infrequent usage of LifeGuide in the creation of logic by users with no programming experience. Similarly to other software packages such as SPSS or Word as users gain in experience they utilise additional features with the aim of increasing productivity and effectiveness. The LogicBlocks graphical user interface supports the transition to the LifeGuide command line interface by displaying the parsed equivalent of blocks in their textual format. In both interfaces as the level of complexity and commands increases the more difficult it can be to

read and follow the logic. Sections and commenting can be utilised in both interfaces to group relevant logic and aid readability. The tasks described in the previous chapter highlight the most common logic functionality required in intervention development, this logic can be clearly represented in LogicBlocks. Although LogicBlocks can accommodate for complex intervention logic such as complicated branching and multiple sections the blocks occupy a large proportion of screen real-estate which can be difficult to read. For complex intervention which will ultimately be relevant for more experienced users it may be more appropriate to utilise the command line interface. Provision of both interfaces in LifeGuide would allow users to flow between the blocks view which may be more appropriate in viewing an overview of the logic and the textual command view to enter more complex logic.

8.3.3. Expanding Toolbox

LifeGuide currently provides functionality to cater for the most common components utilised in the development of Internet Interventions, however the intention is the tool would be an ever expanding tool box allowing for additional components to be incorporated.

8.3.4. Necessity of a Software Developer

The aim of this research was to empower healthcare researchers through the provision of an accessible tool to facilitate the creation of Internet Interventions and thus reduce the reliance on software developers. In addition to removing this reliance the requirement for such a tool also included the potential to reduce the high

costs attributed to bespoke software development; to support prototyping and investigation of ideas and to provide opportunities for reusability. There is however circumstances when a professional software developer cannot be replaced by the provision of a tool and a bespoke solution is required such as:

- The intervention requires to be combined with external resources
- The intervention provides access to medical health records
- The underlying logic/algorithms are too complex for a non-programmer
- The tool does not provide the required components

8.4. Contribution to Healthcare Research

This thesis identified the lack of a usable tool in the creation of Internet Interventions by healthcare researchers in 2007; however this still remains a pertinent issue as evidenced by:

The author (software developer) as part of a multi-disciplinary project team has recently developed an Internet Intervention (2013) funded by the Chief Scientist Office (CSO) targeted at Young People with Asthma in the promotion of Physical Activity (Williams, CZH/4/664, *“Development of Interventions to Increase Physical Activity Among Inactive Young People with Long-term Conditions: MRC Complex Intervention Framework Phase I Study using Asthma as an Exemplar”*).

A subsequent project was recently funded by the CSO (January 2014) also requiring the development of an Internet Intervention (CZH/4/1025, *“Development of Interventions to reduce patient delay with symptoms of Acute Coronary Syndrome: identifying optimal content and mode of delivery”*).

8.5. Reusable Approach – Mobile Intervention

Development

It was through the replication of functionality relating to Internet Intervention creation that the author identified the current lack of a usable tool for healthcare researchers. Similarly the lack of a tool in the creation of mobile phone based behaviour change interventions has been identified. The feasibility of a mobile phone based messaging intervention was successfully demonstrated in a pilot study focused on reducing alcohol intake (Irvine *et al*, 2012).

Subsequently two further studies have been successfully funded with the author as co-applicant by the National Institute for Health Research (NIHR) to deliver mobile phone based interventions, (11/3050/30, “*Reducing binge drinking among disadvantaged men through a brief intervention delivered by mobile phone: a multi-centred randomised controlled trial*”) and (12/139/12, “*Reducing alcohol consumption in obese men: development and feasibility testing of a complex community-based intervention*”).

Identification of the common functionality required in all three studies such as message schedules, types and reply handling led to the development of the prototype tool TextApp; an interface designed adopting user-centred design techniques to reduce the reliance of healthcare researchers on professional software developers in the creation of mobile phone based interventions.

Chapter 9 Associated Publications and Other Outcomes

9.1. Conferences/Presentations

This research was presented at:

1. **Jones C**, Treweek S, Ricketts IW, LogicBlocks: A Graphical User Interface to Facilitate Intervention Logic. Teesside University, Middleborough, 19th April 2013.

2. **Jones C**, Treweek S, A web-based intervention modelling experiment (WIME) using LifeGuide. Teesside University, Middleborough, 19th April 2013.

3. **Jones C**, Treweek S, Ricketts IW, A web-based intervention modelling experiment (WIME) using LifeGuide: Observations. . Teesside University, Middleborough, 19th April 2013.

4. **Jones C**, Treweek S, Ricketts IW, LogicBlocks: Web-Based Health Intervention Creation - No Programmer Required. Division of Health Psychology, British Psychological Society, London. 1st November, 2012.

5. **Jones C**, Treweek S, A web-based intervention modelling experiment (WIME) using LifeGuide. Division of Health Psychology, British Psychological Society, London. 1st November, 2012.

6. **Jones C**, Treweek S, Ricketts IW, LogicBlocks: A Graphical User Interface to Facilitate Intervention Logic. CPD Workshop, Health Psychology Group, Aberdeen University, Aberdeen , 4th October 2013.

7. **Jones C**, Ricketts I, Treweek S. LogicBlocks: Web-Based Health Intervention Creation: No Programmer Required. Scottish School of Primary Care Annual Conference, Glasgow, UK, 24th-25th April 2012.

8. Treweek S, Barnett K, MacLennan G, Bonetti D, Eccles M, Francis J, **Jones C**, Pitts NB, Ricketts IW, Weal M, Sullivan F. Is an email invitation a more effective strategy for recruiting GPs than a postal invitation? Scottish School of Primary Care Annual Conference, Glasgow, UK, 24th-25th April 2012.

9. Treweek S, Sullivan F, Francis J, Ricketts IW, Eccles M, Bonetti D, MacLennan G, Pitts N, **Jones C**, Barnett K, Weal M, Web-based intervention modelling experiments: a way of exploring primary care interventions before a full-scale trial, Scottish School of Primary Care Conference, Edinburgh, April, 2011.

10. **Jones C**, Ricketts IW, Treweek S, A visual tool enabling healthcare researchers to design, deliver and evaluate web-based interventions questionnaires and multimedia resources, NRP Symposium, Dundee, Jan 2011.

11. **Jones C**, Ricketts IW, Treweek S, A tool to support the development, delivery, modelling and evaluation of complex interventions: Web-based Intervention

Modelling Experiments (WIMEs), Sociotechnical issues in Healthcare SICSA Conference, Glasgow April 2010.

12. **Jones C**, Ricketts IW, DiAMOND – Decision Aid for Mode of Next Delivery – Social Dimensions of Health Institute Healthcare Showcase 2007.

9.2. Publications

1. Treweek S, Bonetti D, MacLennan G, Barnett K, Eccles M, **Jones C**, Pitts N, Ricketts I, Sullivan F, Weal M and Francis J, " Paper-based and web-based intervention modelling experiments identified the same predictors of general practitioners' antibiotic-prescribing behavior", *Journal of Clinical Epidemiology* (2014), Elsevier, pp.296-304. doi: 10.1016/j.jclinepi.2013.09.015.

2. Treweek S, Barnett K, MacLennan G, Bonetti D, Eccles M, Francis J, **Jones C**, Pitts N, Ricketts I, Weal M and Sullivan F, "E-mail invitations to general practitioners were as effective as postal invitations and were more efficient", *Journal of Clinical Epidemiology* (2012), Elsevier, pp.1-5. doi: 10.1016/j.jclinepi.2011.11.010. ISSN: 0895-4356.

3. Treweek S, Ricketts I, Francis F, Eccles M, Bonetti D, Pitts N, MacLennan G, Sullivan F, **Jones C**, Weal M and Barnett K , "Developing and evaluating interventions to reduce inappropriate prescribing by general practitioners of antibiotics for upper respiratory tract infections: A randomised controlled trial to compare paper-based and web-based modelling experiments" , *Implementation Science*, 6(16) (2011). doi: 10.1186-5908-6-16.

4. Emmett, C.L., Montgomery A. A., & Murphy D. J. on behalf of the **DIAMOND Study Group**, Preferences for mode of delivery after previous caesarean section: what do women want, what do they get and how do they value outcomes? Dec-2011 In: Health Expectations. 14 (4), p. 397 - 404. 8 p.
5. Emmett, C.L., Murphy D. J., Patel R. R., Fahey T, **Jones, C**, Ricketts I, Gregor P, M. MacLeod and A. A. Montgomery, "Decision making about mode of delivery after previous caesarean section: development and piloting of two computer-based decision aids", Health Expectations, 10 (2007), Blackwell Publishing, pp.161-172. ISSN: doi.10.1111/j.1369.7625.2006.004.29.x.
6. Montgomery A. A., Emmett, C.L., Fahey T, **Jones, C**, Ricketts I, Patel R. R., Peters, T.J. and Murphy D. J, "Two decision aids for mode of delivery among women with previous caesarean section: randomised controlled trial", British Medical Journal, 334 (2007), pp.1305-1309. ISSN: doi:10.1136/bmj.39217.671019.55.
7. Emmett, C.L., Shaw ARG, Montgomery A. A., Murphy D. J, Gregor P, **Jones C** and Ricketts I and the DIAMOND Study Group, "Women's experience of decision making about mode of delivery after a previous caesarean section: the role of health professionals and information about health risks", International Journal of Obstetrics and Gynaecology (2006), Blackwell Publishing, pp.1438-1445. ISSN: 1471-0528.
8. Montgomery A. A. and the **DIAMOND Study Group**, "The DIAMOND trial protocol: a randomised controlled trial of two decision aids for mode of delivery

among women with a previous caesarean section", BMC Pregnancy and Childbirth (2004). ISSN: 1471 2393 4 25.

9.3. Software Output

The information website developed as part of the DiAMOND Study (Case Study 1, Chapter 3) can still be accessed through the Health Talk Online Website (http://www.healthtalkonline.org/Pregnancy_children/Making_decisions_about_birth_after_caesarean/Topic/2038/diamond)

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Appendices

Appendix 1: Potential Intervention Development Tools

[illegible]

Appendix 2: NEXUS Questionnaires

Appendix 2.1: Pre-intervention lumbo-sacral spine x-ray Form

Background

1. Are you? (*Please tick the appropriate box*) Male ☐ Female ☐
2. What year did you qualify?
Year
3. Are you a GP trainer in a vocational training scheme? (*Please tick the appropriate box*) Yes ☐ No ☐

Introduction to the Patient Scenario Task

The following 10 scenarios differ slightly in various elements which may influence your decision to refer a patient with back pain for an x-ray, including whether or not the patient is “your own” or normally cared for by a partner. We appreciate how unlikely it is that you would see a surgery composed solely of patients with back pain, as this set is arranged. We are also aware that the scenario format means that skills you may normally draw on, such as evaluating non-verbal clues from the patient, cannot be a factor in your assessment. Nevertheless, given this understanding, we hope that you address **each** scenario and make a referral decision and on the accompanying scale ring the number that best indicates how difficult this decision was. We have left space for you to comment on your referral decisions, if you so choose.

Patient Scenarios

1. The first patient is a 50-year-old woman who normally sees one of your partners for the treatment of her menopausal symptoms. She tells you that she has been back and forth to the surgery every week for a month, and that her back pain began a few days before she first came in. She thinks that your partner has not been taking her seriously because of her age and she looks to you to do something more tangible than just giving her more painkillers. She makes it very clear that she thinks she should be referred for an x-ray.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

2. The next patient is a 70-year-old man. This is the first time he has come to see you about back pain. He describes his pain as constant, with sudden shooting pains right down both legs, which he has been feeling for the past 2 months. He has had similar problems before, but they have gone away in time. However, this time the problem is taking longer to shift and that is making him feel a bit frightened.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

3. The next patient is a 16-year-old girl, attending alone. This is her second visit to the surgery. She has been feeling very tired and unwell for over a month. She has a dull ache in the centre of her back, although it does not appear to be related to any movement she makes. She does not seem worried, but rather appears listless and almost uninterested.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

4. The next patient is a 64-year-old man, whose daughter and grandchild you see regularly because of the child's asthma. He describes his central back pain as sharp, stabbing and almost continuous. The pain makes it difficult for him to bend over or sit down. He talks to you about how tired he always feels. You have seen him twice before for this problem. It has been 1 week since you last saw him, so he now has been experiencing this level of pain for a month. The painkillers you prescribed at the last visit do not seem to be relieving the problem.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

5. The next of your patients is a 70-year-old woman. She has been back and forth from the surgery every week for the last three weeks, after three days of aching lower back pain. She has asked you about getting an x-ray at every visit. This visit she asks for an x-ray again, more or less telling you that she thinks that you are not paying the attention that you should to her problem because she is old.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

6. The next patient is a 15-year-old boy, who comes in with his mother. This is their second visit to the surgery. At the first visit, the mother said that he was complaining of a sharp pain in his lower right back and an achy right leg for the previous two weeks. It is 10 days later now, and he is still demonstrating difficulty bending over or

moving from side to side. The boy tells you that he cannot remember when the pain first started, just that it is happening all the time. The child is upset and his mother is very worried, particularly because you had said on the previous visit that the problem should be clearing up by now.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

7. The next patient is a 30-year-old woman. She is a frequent attendee at the surgery, both for herself and for her children. She has been experiencing throbbing pain in the lower left hand side of her back for the last month, although she cannot remember exactly when it first started or what she was doing. She begins to cry as she describes the problem she is having in lifting her 9-month baby and her toddler and generally keeping up with them because of her pain. She has not had any similar problems before. She has been taking Paracetamol for most of this time, but she feels they do not really help, and she is concerned about the effects of taking painkillers for such a long time. She has tried aromatherapy massage, but that has not helped either. She wants to know what you can do for her.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

8. The next patient is a 72-year-old woman whom you know quite well, having cared for her husband during his terminal illness. She came to see you a week ago with a severe ache in her lower back for the preceding 2 weeks. She had described similar episodes in the last few years, which she put down to old age. She came to you because the pain is now radiating down into her left leg. There are no neurological signs and the blood tests you ordered (Full Blood Count and ESR) have come back normal. Nevertheless, the pain is showing no signs of letting up, and she is becoming very anxious about what that might mean.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

9. The next patient is a 50-year-old woman. This is the first time she has come to see you in relation to her back pain. She describes a constant dull ache, with sudden shooting pains down both legs into her calves, which she has been feeling for the past 2 months. She has had similar problems before, but this time she feels that the pain has escalated. She says she is having trouble doing her housework and getting around because her legs feel quite weak and she is worried that they may give way. She is very distressed about this.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

10. The next patient is a 72-year-old man. He came to see you a week before with a bad ache in his lower back, which he had been experiencing for the previous 2 weeks. He had described similar episodes in the last few years, which had cleared up over a week or so. However, the pain is now radiating down into his left leg. Although there are no other neurological signs, the pain is showing no signs of letting up. He is becoming increasingly more worried about the problem.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

ABOUT THESE QUESTIONS

This questionnaire contains items about elements, which may influence your decision to refer a patient with back pain for a lumbo-sacral spine x-ray, in addition to the purely clinical. The questionnaire items are based on a qualitative study of GP and patient attitudes toward x-rays. **This is not a test.** There is no right or wrong answers for any of the items. The main thing to remember is to answer as honestly as possible, not what you think you should answer or what we want to see. Please understand that your answers are completely confidential. Try not to take too long over each response or worry about consistency - what first comes to your mind is more likely reflect what you really believe.

For patients presenting with back pain and to lumbo-sacral spine x-rays. (Please circle only one number for each item)

- | | | | | | | | | | |
|---|-------------|---|---|---|---|---|---|---|-----------|
| 1. An x-ray will reassure the patient: | Unlikely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Likely |
| 2. Reassuring the patient is: | Unimportant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Important |
| 3. An x-ray will allay my uncertainty: | Unlikely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Likely |
| 4. Allaying my uncertainty is: | Unimportant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Important |
| 5. Referring a patient for an x-ray will decrease future consultations: | Unlikely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Likely |
| 6. Decreasing future consultations is: | Unimportant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Important |

- | | | | | | | | | | | |
|-----|---|----------------------------|---|---|---|---|---|---|---|-----------------------------|
| 7. | An x-ray will make me more confident about managing the patient's symptoms: | Likely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Unlikely |
| 8. | Being confident about managing the patient's symptoms is: | Unimportant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Important |
| 9. | How difficult is it to make a diagnosis without an x-ray? | Very difficult | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Not at all |
| 10. | In general, how difficult is it to make the decision to refer a patient for an x-ray? | Very difficult | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Not at all |
| 11. | My making a diagnosis without an x-ray is: | Less likely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | More likely |
| 12. | For me, referring a patient for an x-ray is: | Less likely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Very likely |
| 13. | I would rather decide myself about referring for an x-ray instead of just following guidelines: | Strongly Agree | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Strongly Disagree |
| 14. | In general, the possible harm to the patient of a lumbar spine x-ray is outweighed by its benefits: | Definitely Yes | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Definitely No |
| 15. | In regard to my decision to x-ray: | | | | | | | | | |
| | a) Doing what patients think I should do is: | Unimportant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Important |
| | b) Doing what my colleagues think I should do is | Unimportant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Important |
| | c) Doing what the NHS thinks I should do is: | Unimportant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Important |
| 16. | How confident are you in your ability to diagnose back problems without an x-ray? | Extremely Confident | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Not at all Confident |
| 17. | How confident are you in your ability to treat back problems without an x-ray? | Extremely Confident | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Not at all Confident |
| 18. | How confident are you in your ability to | Extremely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Not at all |

present a diagnosis to a difficult or **Confident**
 anxious patient without an x-ray?

Confident

19. How confident are you in your ability to **Extremely** 1 2 3 4 5 6 7 **Not at all**
 follow guideline recommendations for **Confident** **Confident**
 x-ray referral

20. For every 10 patients, approximately how many would you
 refer for an x-ray:

- a) presenting with acute back pain for the **first** time 1 2 3 4 5 6 7 8 9 10
- b) presenting with acute back pain for the **second** time 1 2 3 4 5 6 7 8 9 10
- c) presenting with acute back pain for the **third** time 1 2 3 4 5 6 7 8 9 10

Please return the scenarios marked with your referral decisions and the completed questionnaire to us in the enclosed pre-paid envelope. Thank you for your participation in this study, your contribution is very much appreciated.

Appendix 2.2: Post-intervention lumbo-sacral spine x-ray Form

Introduction to the Patient Scenario Task

First of all, thank you very much for continuing your participation in this research. The following 10 scenarios again include various elements, which may influence your decision to refer a patient with back pain for an x-ray. Once more, we appreciate that the scenario format means that skills you may normally draw on, such as evaluating non-verbal clues from the patient, cannot be a factor in your assessment. Nevertheless, we ask you to address each scenario and make a referral decision. Your responses will be completely confidential, so please answer as honestly as possible, not what you think we want to see. We have left space for you to comment on any aspect of a scenario, or your decision, if you so choose.

Patient Scenarios

1. The first patient is a 29-year-old woman, who comes into your surgery, limping and holding her back. She describes her back pain as sharp and unceasing. She has had it for the last 3 weeks, and for the last week, she has been unable to go to work because she cannot drive. She is very worried that whatever is causing her problem is getting worse. She has had no previous episodes. Her last six attendances have been for repeat prescriptions for oral contraceptives.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

2. The next patients is a 49-year-old man. This is his third visit to the surgery. He has had a problem with his back for about 12 weeks, although he thinks it is getting better. The pain does not radiate and he has no neurological signs. He is still losing weight, but is sleeping more now. He tells you that he is not particularly worried about his condition, but he wants more of the painkillers (Co-codamol), which he thinks have been very helpful. He tells you that he really would rather not get an x-ray.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

3. The next patient is a 30-year-old woman. This is her second visit to the surgery. She has had the problem with her back for about 3 months, with the severity of the pain fluctuating over this period, sometimes getting worse with rest. She tells you she has not been right since the really bad flu she had, and that she still is occasionally

feeling her temperature rise at night. She does not appear particularly worried about her condition, but she is getting very tired of the persistent pain. She tells you she would rather try some stronger painkillers than get an x-ray.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

4. The 45-year-old woman who comes in next is a patient of your partner who is currently on holiday. For the past 3 weeks, she has been experiencing very sharp pain in her lower back when she moves suddenly, and a dull ache the rest of the time. Your partner had prescribed painkillers 10 days before, but the problem is still persisting. You see from her notes that she had inflammatory bowel disease six months previously, which had responded well to treatment. Nevertheless, she is very worried about her symptoms and what they may mean, and feels that the problem has persisted long enough for her not to be, as she puts it, "fobbed off" with more painkillers.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

5. The next patient is 49-year-old man who you usually see for the management of his hypertension. He walks slowly into your surgery, holding his back and grimacing. He sits with a loud groan. He describes his pain as very severe, with shooting pains whenever he moves. This episode onset was sudden (he just bent over to pick something up from the floor), but he has had similar episodes in the past. The pain has persisted for a period of 3 weeks, most of which he has taken off work. He thinks this is the worst episode yet, and is very worried that whatever is causing his problem is getting worse.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

6. The next patient is a 50-year-old man. He claims that he has been back and forth from the clinic for a month, seeing one of your partners, and he is extremely unhappy with being palmed off with more painkillers every time he comes in. He is very belligerent, stating that his back pain is getting worse and that this time he really wants to get his back x-rayed.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

7. The next patient is a 68-year-old woman, who has had a throbbing pain in her lower back for the last 3 weeks. This is her third visit to you. She has been more and more upset each time she has returned, though there has never been anything to find on examination. You find out, this visit, that her husband (who was registered with another practice) died from cancer in his spine about a year before, and that she is recognising in herself some similar symptoms from an early stage of his illness.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

8. The next patient is a 16-year-old boy. He hurt his back when he was playing rugby. He had to miss the game the week after because he was still too stiff, and he hated doing that. The next week he was feeling completely better so he played, but he had to come off before the end of the game because his back was hurting him so much. It is now a week later and he is still in considerable pain. He is really anxious that this will happen every time he plays, particularly since he plans to play as a career. All movements of his lumbar spine are restricted by pain at the limits of movement.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

9. The next patient is a 69-year-old woman, who has had osteoarthritis for ten years. She is extremely upset. She has had low back pain for the last week, which she describes as excruciating. The pain radiates down the back of her right leg, although not below her knee (indeed, there are no neurological signs). She does not remember doing anything that may have caused it. You saw her once before for an episode of back pain, fifteen months ago, which went away in a few days. She tells you that the pain is in a similar place, but much worse. She has been taking painkillers, but with no effect.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

10. The next patient is a 74 year old man. This is his first visit in relation to the shooting pain he is feeling in his back and in both legs. This episode is not the first time he has had back problems, but he is a bit hazy on the details. He says he has been experiencing the pain for a few weeks, but has put off coming to see a doctor because he hoped it would go away. He has been taking painkillers, which he thinks provide some relief. His wife made him come today. She is worried about him not getting out of the house at all because of how sore and stiff he feels. There are no neurological signs.

Refer for x-ray: Yes ☐ No ☐

On the scale 1 to 10, how difficult was it for you to make a decision for this scenario?

Not at all 1 2 3 4 5 6 7 8 9 10 Extremely Difficult

If you wish to comment on this referral decision, please do so here.

LUMBO-SACRAL SPINE X-RAY QUESTIONNAIRE

This questionnaire is very similar to the one you previously completed. Try not to think about how you answered before and please do not deliberately try to be consistent. Just answer as honestly as possible, not what you think you should, or what we want to see. Again, **this is not a test**. There is no right or wrong answers for any of the items. Try not to take too long over each answer - what first comes to mind is more likely to be what you believe. Please understand that your answers are completely confidential. No one outside the research team will have access to the information collected during the course of this study.

The following items all refer to patients presenting with back pain and to lumbo-sacral spine x-rays:

- | | | | | | | | | | | |
|---|---|--------------------|---|---|---|---|---|---|---|--------------------|
| 1 | An x-ray will reassure the patient: | Unlikely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Likely |
| 2 | Reassuring the patient is: | Unlikely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Likely |
| 3 | An x-ray will allay my uncertainty: | Unimportant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Important |
| 4 | Allaying my uncertainty is: | Unimportant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Important |
| 5 | Referring a patient for an x-ray will decrease future consultations | Unlikely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Likely |
| 6 | Decreasing future consultations is: | Important | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Unimportant |
| 7 | An x-ray will make me more confident about managing the patient's symptoms: | Likely | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Unlikely |
| 8 | Being confident about managing the patient's symptoms is: | Unimportant | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Important |
| 9 | How difficult is it to diagnose without an | Very | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Not at all |

x-ray		difficult							
10	In general, how difficult is it to make the decision to refer a patient for an x-ray:	Very difficult	1	2	3	4	5	6	7 Not at all
11	My making a diagnosis without an x-ray is:	Less Likely	1	2	3	4	5	6	7 More likely
12	For me, referring a patient for an x-ray is:	Less Likely	1	2	3	4	5	6	7 Very Likely
13	I would rather decide myself about referring for an x-ray	Less Likely	1	2	3	4	5	6	7 Very Likely
14.	In general, the possible harm to the patient of a lumbar spine x-ray is outweighed by its benefits:	Definitely Yes	1	2	3	4	5	6	7 Definitely No
15.	In regard to my decision to x-ray:								
	b) Doing what patients think I should do is:	Unimportant	1	2	3	4	5	6	7 Important
	b) Doing what my colleagues think I should do is:	Unimportant	1	2	3	4	5	6	7 Important
	c) Doing what the NHS thinks I should do is:	Unimportant	1	2	3	4	5	6	7 Important
16.	How confident are you in your ability to diagnose back problems without an x-ray?	Extremely Confident	1	2	3	4	5	6	7 Not at all Confident
17.	How confident are you in your ability to treat back problems without an x-ray?	Extremely Confident	1	2	3	4	5	6	7 Not at all Confident
18.	How confident are you in your ability to present a diagnosis to a difficult or anxious patient without an x-ray?	Extremely Confident	1	2	3	4	5	6	7 Not at all Confident
19.	How confident are you in your ability to follow guideline recommendations for x-ray referral	Extremely Confident	1	2	3	4	5	6	7 Not at all Confident

20.

For every 10 patients, approximately how many would you refer for an x-ray:

a) presenting with acute back pain for the **first** 0 1 2 3 4 5 6 7 8 9 10
time

b) presenting with acute back pain for the **second** 0 1 2 3 4 5 6 7 8 9 10
time

c) presenting with acute back pain for the **third** 0 1 2 3 4 5 6 7 8 9 10
time

21

If you do not refer for an x-ray and the patient's condition deteriorated, how would you feel:

(please respond to all 3 parts of this question)

i) responsible **Extremely** 1 2 3 4 5 6 7 **Not at all**

ii) guilty **Extremely** 1 2 3 4 5 6 7 **Not at all**

iii) confident you had made the right **Extremely** 1 2 3 4 5 6 7 **Not at all**
decision

Please return the scenarios marked with your referral decisions and the completed questionnaire to us in the enclosed pre-paid envelope. Thank you for your participation in this study, your contribution is very much appreciated.

Appendix 3: LogicBlocks Evaluation Participant Information Sheet

Web-based Healthcare Research - No Programmer Required

Introduction

LifeGuide allows researchers to create web-based interventions, questionnaires or information websites without the need for a software developer. However to control these web-based tools requires logic.

Logic is used to:

1. control the page order
2. control user management
3. to dynamically tailor an intervention based on participants responses, e.g. don't ask a male participant if pregnant
4. to allow for group randomisation

SCENARIO:

A recent randomised controlled trial focused on lowering antibiotic prescribing by doctors for upper respiratory tract infections (URTI). The intervention created consisted of:

- Login Page
- Consent Page
- Voucher Selection
- Randomisation to Action Plan, Persuasive Communication or No Intervention
- Questionnaire Section
- Patient Scenarios

This example intervention will provide the basis for all the tasks you will be asked to complete today. The pages have already been created for you using the LifeGuide Authoring Tool. This authoring tool provides users with a tool box of components such as input controls in the form of text boxes and radio buttons, images, and navigational controls.

Most questions are answered by selecting one number; a few require more time to answer.
Some questions are worded very similarly but they are different and it is important for the study that you answer them all.
Please try not to take too long over each response as we would like to know your immediate views and experiences.
Your answers are completely confidential.

1. From memory, approximately how many of the last 10 patients who presented with an URTI for the first time, did you manage without prescribing an antibiotic

0 1 2 3 4 5 6 7 8 9 10

2. I feel under pressure to manage patients with URTIs without prescribing an antibiotic:

	1	2	3	4	5	6	7
a) from patients	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) from secondary care colleagues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) from colleagues within the practice	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) from feedback provided by PACT	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) from published literature	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

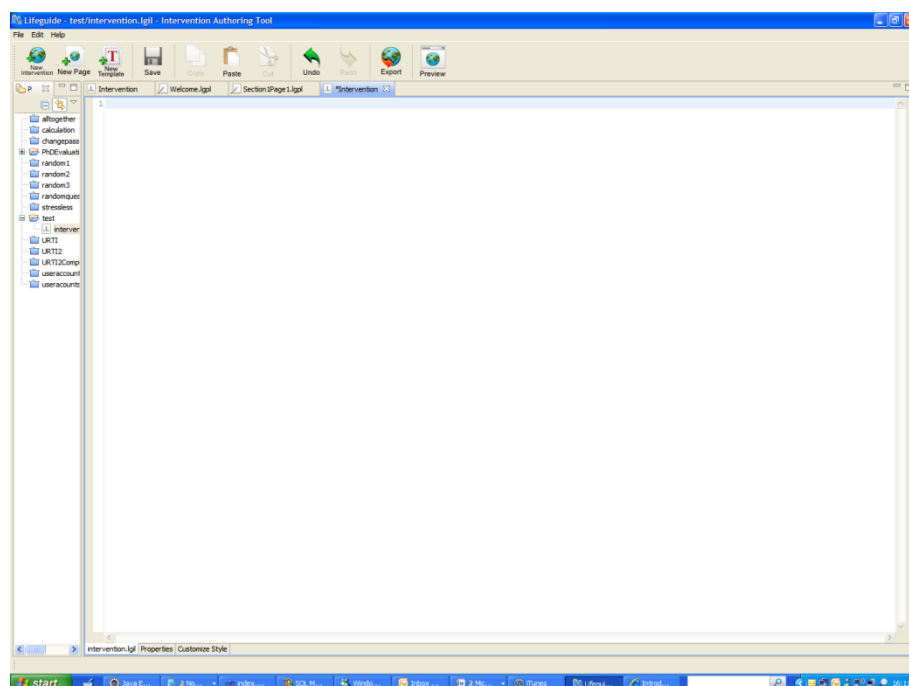
Strongly disagree Strongly agree

Back Progress Next

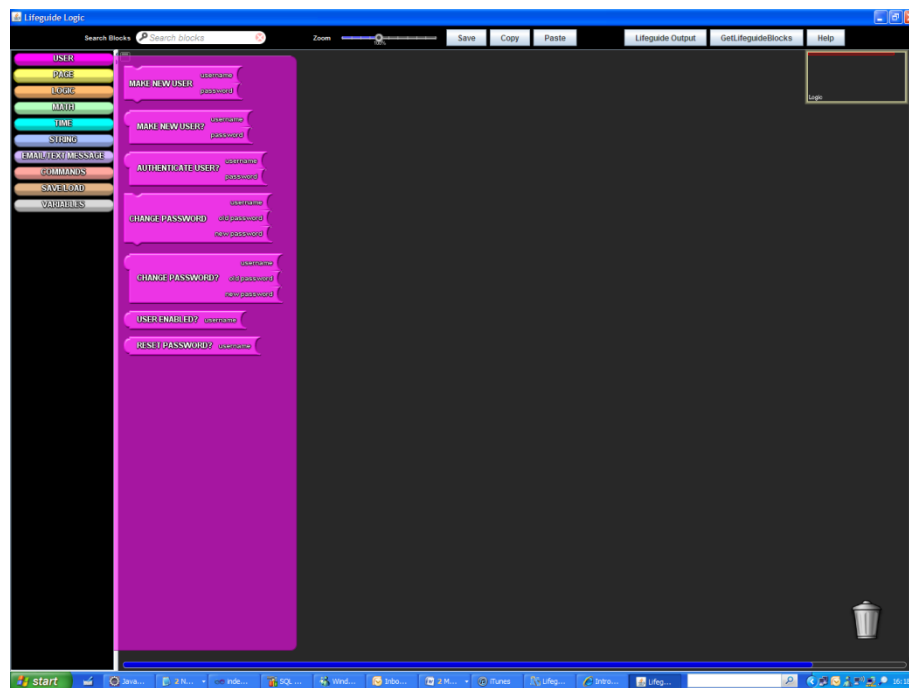
INTERFACES:

The purpose of the tasks is to evaluate two different interfaces for entering intervention logic, a textual command interface and a graphical interface.

TEXTUAL COMMAND INTERFACE



Logic is entered by typing appropriate syntax into the window depicted above.

GRAPHICAL INTERFACE:

Logic is entered by dragging and combining blocks from the menus depicted in the window above.

Appendix 4: LogicBlocks Evaluation Participant Consent Form

Web-based Healthcare Research - No Programmer Required

Information and Consent Form

FOR QUESTIONS ABOUT THE STUDY, CONTACT: Claire Jones on

DESCRIPTION: You are invited to participate in research that seeks to allow anyone interested in creating web-based health interventions, information websites or questionnaires. In this session, you will be asked to carry out tasks using both a textual command interface and a graphical interface in order to answer some questions. The questions will be about how easy to use you think the interfaces are. After the tasks are complete you will be invited to discuss what you thought of the interfaces and which if either you preferred. Timings for task completion will be recorded, these recordings are to test the system not you so take your time and do not worry if you don't complete a task. The session will be audio/video recorded on your consent.

RISKS AND BENEFITS: The risks associated with this are minimal. It is not anticipated that you will experience any unusual amount of stress or discomfort as a result of participating in this. The benefit is that you will be evaluating possible solutions which you can make use of in your own research to create web-based solutions without the need for a software developer.

TIME INVOLVEMENT: Your participation is expected to be approximately 1 hour.

EXPENSES: As a token of our appreciation, you will receive a gift voucher.

PARTICIPANT'S RIGHTS: If you have read this form and have decided to participate, please understand that your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time without penalty. You have the right to refuse to answer particular questions or complete the evaluation tasks. Your individual privacy will be maintained in all published and written data resulting from the study. Only key researchers will be able to access all the data collected, including personal details. Other researchers may be able to view anonymous parts of your data.

If you have questions about your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact - anonymously, if you wish – Claire on ... or email ...

I am over 18 years old and have read the foregoing and fully understand the contents thereof.

Sign

Print Name

Today's date

Researcher's Signature

Appendix 5: LogicBlocks Evaluation Background Questionnaire

Web-based Healthcare Research - No Programmer Required

Background Questionnaire

Please answer the following questions. All of your answers will be treated confidentially. Any published document regarding these answers will not identify individuals with their answers. If there is a question you do not wish to answer, please leave it blank and go onto the next question.

SECTION 1 – PERSONAL INFORMATION

1. Gender: ☐ Male ☐ Female
2. Age: ☐ <20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐ >60

SECTION 2 – INTERVENTION DEVELOPMENT

3. Have you ever been involved in developing/creating healthcare related interventions, information resources or questionnaires?
☐ Yes ☐ No

If you answered Yes:

- a. How many such resources have you developed/created?
- b. How were the resources created?

- ☐ Paper Based
- ☐ Made use of available software tool - if so please provide details
- ☐ I developed software
- ☐ Developed by another member of the team
- ☐ Developed by a software developer

SECTION 3 – PREVIOUS TECHNOLOGY USE

4. I feel comfortable with computers.

1 2 3 4 5
Strongly Disagree Strongly Agree

5. How often do you use a computer?

- ☐ Several times a day
- ☐ About once a day
- ☐ 3-5 times a week
- ☐ Less often

6. How would you rate your level of computer experience?

1 2 3 4 5
Novice Expert

7. How would you rate your computer usage?

- ☐ Never Used
- ☐ Can browse the Internet
- ☐ Can use Word Package
- ☐ Can change settings
- ☐ Can use the command line

SECTION 3 – PROGRAMMING EXPERIENCE

8. Have you ever written a formula in Excel (or similar spreadsheet package)?

Yes ☐ No ☐

If you answered Yes:

a. How often do you write these types of formula?

☐ Daily ☐ Weekly ☐ Monthly ☐ Yearly

b. How easy did you find this task?

1 2 3 4 5
Very Difficult Very Easy

9. Have you ever written 'Syntax' in SPSS (or similar statistics package)?

Yes ☐ No ☐

If you answered Yes:

a. How often do you write this type of 'Syntax'?

☐ Daily ☐ Weekly ☐ Monthly ☐ Yearly

b. How easy did you find this task?

1 2 3 4 5
Very Difficult Very Easy

10. Do you have any experience writing computer programs?

☐ Yes ☐ No

If you answered Yes:

a. How many years programming experience do you have?

b. How would you rate your level of programming experience?

1 2 3 4 5
Novice Expert

c. How often do you write computer programs?

☐ Daily ☐ Weekly ☐ Monthly ☐ Yearly

11. If you write formulas or logic for any other tasks please provide details including how often and easy you found this?

THANKS FOR YOUR TIME.

Appendix 6: LogicBlocks Evaluation After-Scenario Questionnaire

Web-based Healthcare Research - No Programmer Required

After-Scenario Questionnaire

INSTRUCTIONS:

For each of the statements below, circle the rating of your choice.

1. Overall, I am satisfied with the ease of completing this task.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

2. Overall, I am satisfied with the amount of time it took to complete this task.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

3. Overall, I am satisfied with the support information (on-line help, messages, documentation) when completing this task.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

4. Please provide any further comments you have about this task:

THANKS FOR YOUR TIME.

Appendix 7: LogicBlocks Evaluation After-Interface Questionnaire

Web-based Healthcare Research - No Programmer Required

After-Interface Questionnaire

INSTRUCTIONS:

This questionnaire gives you an opportunity to express your satisfaction with the usability of your primary computer system. Your responses will help us understand what aspects of the system you are particularly concerned about and the aspects that satisfy you.

To as great a degree as possible, think about all the tasks that you have done with the system while you answer these questions.

Please read each statement and indicate how strongly you agree or disagree with the statement by circling a number on the scale. If a statement does not apply to you, write N/A.

Whenever it is appropriate, please write comments to explain your answers.

1. Overall, I am satisfied with how easy it is to use this system.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

2. It is simple to use this system.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

3. I can effectively complete my work using this system.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

4. I am able to complete my work quickly using this system.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

5. I am able to efficiently complete my work using this system.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

6. I feel comfortable using this system.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

7. It was easy to learn to use this system.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

8. I believe I became productive quickly using this system.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

9. The system gives error messages that clearly tell me how to fix problems.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

10. Whenever I make a mistake using the system, I recover easily and quickly.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

11. The information (such as on-line help, on-screen messages and other documentation) provided with this system is clear.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

12. It is easy to find the information I need.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

13. The information provided with the system is easy to understand.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

14. The information is effective in helping me complete my work.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

15. The organization of information on the system screens is clear.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

Note: The interface includes those items that you use to interact with the system. For example, some components of the interface are the keyboard, the mouse, the screens (including their use of graphics and language).

16. The interface of this system is pleasant.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

17. I like using the interface of this system.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

18. This system has all the functions and capabilities I expect it to have.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

19. Overall, I am satisfied with this system.

STRONGLY STRONGLY
AGREE 1 2 3 4 5 6 7 DISAGREE

COMMENTS:

THANKS FOR YOUR TIME.

Appendix 8: Logic Block Evaluation LifeGuide Practice Task

Web-based Healthcare Research - No Programmer Required

Practice Task – Display Pages

INTRODUCTION:

Familiarise yourself with the interface and access the help dictionary. Try entering the letter 'c' in the command window, a context sensitive menu appears with a list of commands, pages and interactions beginning with c.

TASK:

The most important logic task to remember when creating an intervention is how to display pages. If you recall the antibiotic prescribing example the first pages consisted of a Welcome Page, followed by a Consent Page.

The command to display pages is:

```
Show pagename
```

In the textual command interface enter the follow:

```
Show Welcome  
Show Consent
```

Appendix 9: LogicBlocks Evaluation LogicBlocks Practice Task

Web-based Healthcare Research - No Programmer Required

Practice Task – Display Pages

INTRODUCTION:

Familiarise yourself with the interface by looking through the menu options. Try selecting a block and dragging it onto the canvas, then delete it by dragging it to the bin. Access the help dictionary.

TASK:

The most important logic task to remember when creating an intervention is how to display pages. If you recall the antibiotic prescribing example the first pages consisted of a Welcome Page, followed by a Consent Page.

The command to display pages is:



In the graphical interface from the **Page** menu select the **show page** block and select the page name from the drop down list:



Appendix 10: LogicBlocks Evaluation Task 1 – User Management

Web-based Healthcare Research - No Programmer Required

Task One – User Management

BACKGROUND:

The majority of interventions require some sort of user management to keep track of a participant's responses or usage of a system. User management can involve creating user accounts, changing passwords, or checking that a username entered is valid.

SCENARIO:

We have displayed the Welcome page followed by the Consent page but in a real-world study we would normally want to check the username entered is a valid participant in the study.

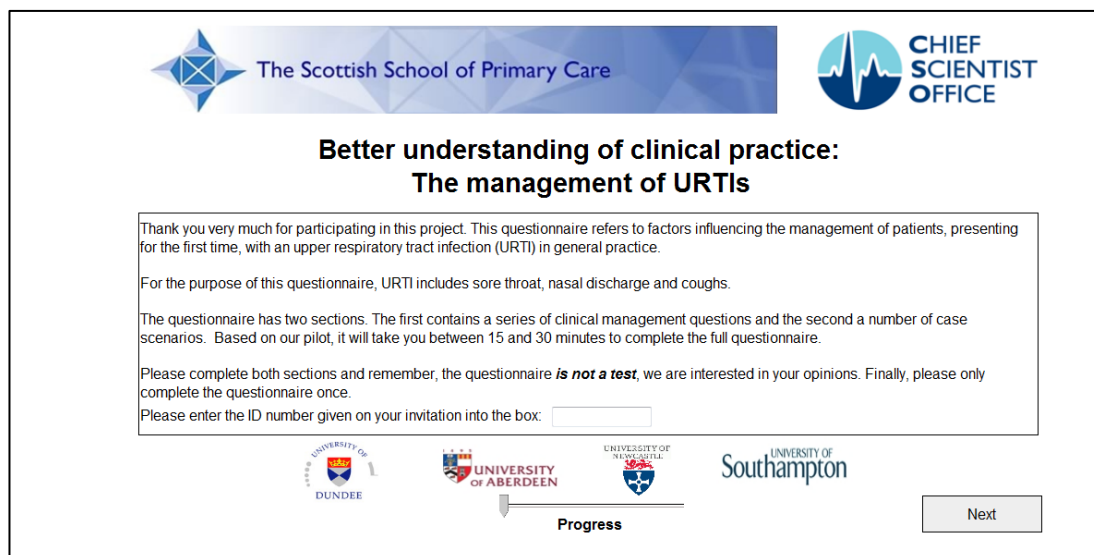
TASK:

The task is to enter the logic required to validate a user before they see the Consent page.

- Display Welcome Page (*Welcome*)
- Check is the username valid? (The username field is called *Welcome.UserId*)
- Display Consent Page (*Consent*)

END OF TASK DESCRIPTION

Appendix 11: LogicBlocks Evaluation Task 1 Screen Shots



The screenshot shows a user welcome page. At the top left is the logo for 'The Scottish School of Primary Care'. At the top right is the 'CHIEF SCIENTIST OFFICE' logo. The main heading is 'Better understanding of clinical practice: The management of URTIs'. Below this is a text box containing the following information: 'Thank you very much for participating in this project. This questionnaire refers to factors influencing the management of patients, presenting for the first time, with an upper respiratory tract infection (URTI) in general practice. For the purpose of this questionnaire, URTI includes sore throat, nasal discharge and coughs. The questionnaire has two sections. The first contains a series of clinical management questions and the second a number of case scenarios. Based on our pilot, it will take you between 15 and 30 minutes to complete the full questionnaire. Please complete both sections and remember, the questionnaire *is not a test*, we are interested in your opinions. Finally, please only complete the questionnaire once. Please enter the ID number given on your invitation into the box: [input field]'. Below the text box are logos for 'UNIVERSITY OF DUNDEE', 'UNIVERSITY OF ABERDEEN', 'UNIVERSITY OF NEWCASTLE', and 'UNIVERSITY OF Southampton'. A 'Progress' bar is shown with a progress indicator. A 'Next' button is located at the bottom right.

The Scottish School of Primary Care

CHIEF SCIENTIST OFFICE

**Better understanding of clinical practice:
The management of URTIs**

Thank you very much for participating in this project. This questionnaire refers to factors influencing the management of patients, presenting for the first time, with an upper respiratory tract infection (URTI) in general practice.

For the purpose of this questionnaire, URTI includes sore throat, nasal discharge and coughs.

The questionnaire has two sections. The first contains a series of clinical management questions and the second a number of case scenarios. Based on our pilot, it will take you between 15 and 30 minutes to complete the full questionnaire.

Please complete both sections and remember, the questionnaire *is not a test*, we are interested in your opinions. Finally, please only complete the questionnaire once.

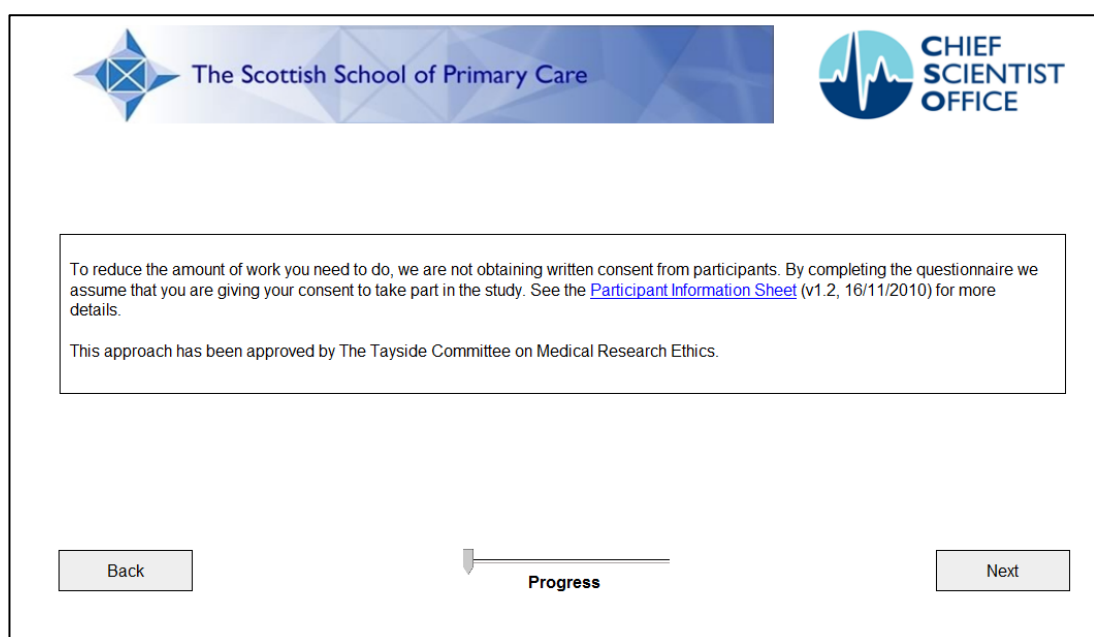
Please enter the ID number given on your invitation into the box:

UNIVERSITY OF DUNDEE **UNIVERSITY OF ABERDEEN** **UNIVERSITY OF NEWCASTLE** **UNIVERSITY OF Southampton**

Progress

Next

Figure A11.1 User welcome page created in LifeGuide



The screenshot shows a consent page. At the top left is the logo for 'The Scottish School of Primary Care'. At the top right is the 'CHIEF SCIENTIST OFFICE' logo. The main text box contains the following information: 'To reduce the amount of work you need to do, we are not obtaining written consent from participants. By completing the questionnaire we assume that you are giving your consent to take part in the study. See the [Participant Information Sheet](#) (v1.2, 16/11/2010) for more details. This approach has been approved by The Tayside Committee on Medical Research Ethics.' Below the text box are 'Back', 'Progress', and 'Next' buttons. The 'Progress' bar is shown with a progress indicator.

The Scottish School of Primary Care

CHIEF SCIENTIST OFFICE

To reduce the amount of work you need to do, we are not obtaining written consent from participants. By completing the questionnaire we assume that you are giving your consent to take part in the study. See the [Participant Information Sheet](#) (v1.2, 16/11/2010) for more details.

This approach has been approved by The Tayside Committee on Medical Research Ethics.

Back **Progress** **Next**

Figure A11.2 – Consent page created in LifeGuide

Appendix 12: LogicBlocks Evaluation Task 2 – Dynamic Tailoring

Web-based Healthcare Research - No Programmer Required

Task Two – Dynamic Tailoring

BACKGROUND:

Using dynamic tailoring of an intervention or questionnaire based on participants responses results in participants only being asked questions or viewing content which is relevant to them.

For example a man being asked if he was pregnant or a non-smoker being asked how many cigarettes they smoke a day.

SCENARIO:

Again using the antibiotic study as an exemplar the next page to be displayed was a voucher page. This page allowed participants to either select a voucher type i.e. Amazon or iTunes or to select that they don't want to take part in the project.

Scenario 1: Participant selects "Not Interested" – directed to *Exit* page

Scenario 2: Participant selects a voucher from the selection – directed to *ConfirmVoucher* page.

TASK:

The task is to enter the logic required to tailor the intervention depending on if the participant selects "Not Interested" or a voucher type.

- Display Voucher Page (*Voucher*)
- Participant Selects "Not Interested" (*Voucher.VoucherOptions*) display *Exit* page (*Exit*)
- Participant selects anything except "Not Interested" (*Voucher.VoucherOptions*) display *ConfirmVoucher* page (*ConfirmVoucher*)

END OF TASK DESCRIPTION

PLEASE INFORM THE RESEARCHER WHEN YOU ARE READY TO BEGIN OR TO SEEK CLARIFICATION

Appendix 13: LogicBlocks Evaluation Task 2 Screen Shots

The Scottish School of Primary Care **CHIEF SCIENTIST OFFICE**

Thanks for your time!

We realise that you have lots of demands on your time so by way of thanks we would like to send you a £20 voucher. You can choose an Amazon, Argos, Boots, iTunes, Love2Shop, M&S, or Starbucks voucher by clicking on the appropriate picture below. We will do our best to make sure that you receive your voucher within two weeks of completing this questionnaire

- ☐ Amazon
- ☐ Argos
- ☐ Boots
- ☐ iTunes
- ☐ Love2Shop
- ☐ Marks and Spencers
- ☐ Starbucks
- ☐ No voucher required
- ☐ Sorry I'm not interested in taking part

Back Progress Next

Figure A13.1 Page created in LifeGuide to demonstrate dynamic tailoring

Voucher Confirmation

You selected <VoucherName>voucher.

Is this correct?

Yes No

Figure A13.2 LifeGuide page showing a tailored response

If you wish to find out more about this study please contact:

Dr
Senior Lecturer, Clinical & Population Sciences and Education
University of Dundee and Assistant Director, Tayside Clinical Trials Unit

Email:
Telephone:

Figure A13.3 LifeGuide page displayed if participant selects not to continue

Appendix 14: LogicBlocks Retention Task

Web-based Healthcare Research - No Programmer Required Task – User Management

BACKGROUND:

The majority of interventions require some sort of user management to keep track of a participant's responses or usage of a system. User management can involve creating user accounts, changing passwords, or checking that a username entered is valid.

SCENARIO:

We want to display a sign up page (*CreateUser*) which will allow a participant to set up a user account with a unique username/email address (*CreateUser.UserId*) and password (*CreateUser.Password*) then send a confirmation email.

TASK:

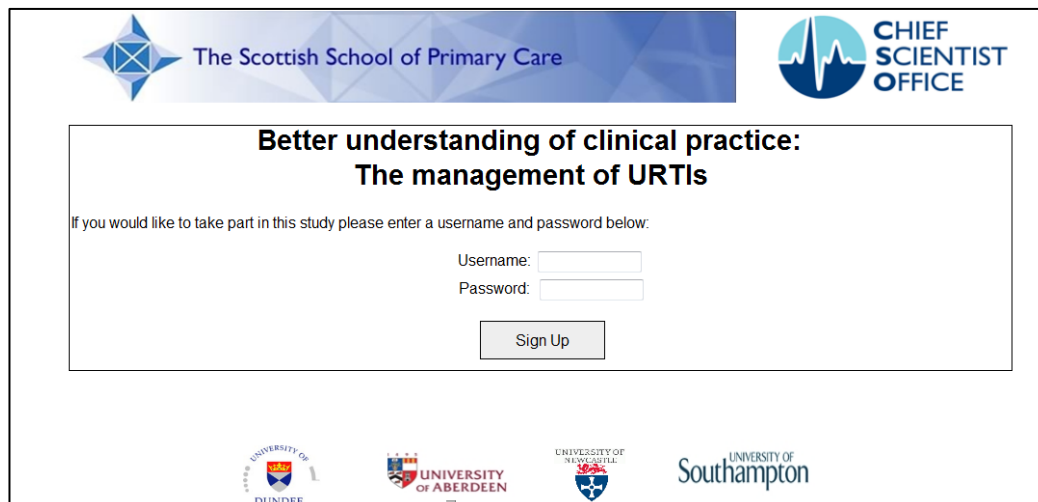
The task is to enter the logic required to create a user then send a confirmation email.

- Display Create User Page (*CreateUser*)
- Create a user with the user details entered (The username/email field is called *CreateUser.UserId* and the password field is called *CreateUser.Password*)
- Send a confirmation email with the subject line – *Confirmation Email* and the content – *Registration Successful*
- Display Confirmation Page (*Confirmation*)

END OF TASK DESCRIPTION

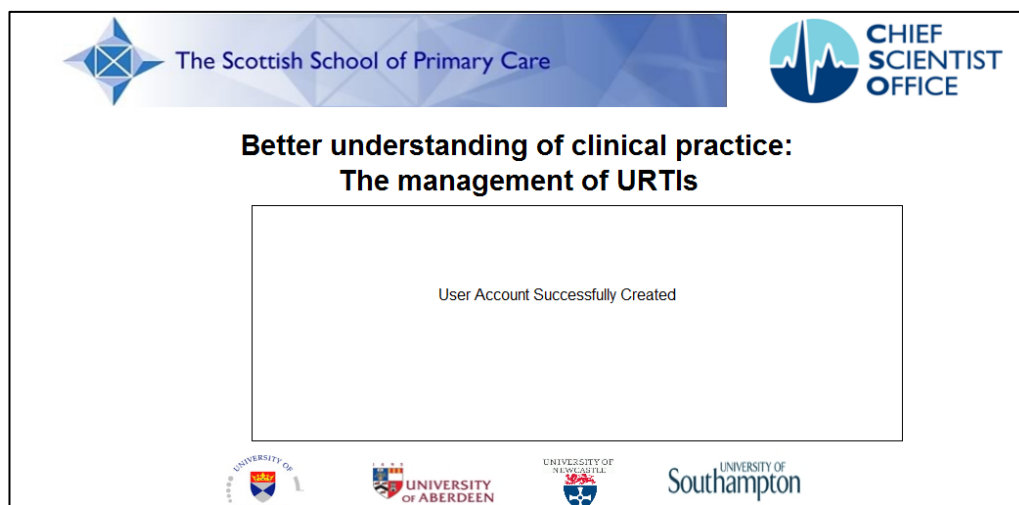
PLEASE INFORM THE RESEARCHER WHEN YOU ARE READY TO BEGIN OR TO SEEK CLARIFICATION

Appendix 15: LogicBlocks Retention Task Screen Shots



The screenshot shows a web page for user registration. At the top left is the logo for 'The Scottish School of Primary Care'. At the top right is the logo for the 'CHIEF SCIENTIST OFFICE'. The main heading is 'Better understanding of clinical practice: The management of URTIs'. Below this, a text prompt says 'If you would like to take part in this study please enter a username and password below:'. There are two input fields: 'Username:' and 'Password:'. Below these fields is a 'Sign Up' button. At the bottom of the page, there are logos for four universities: 'UNIVERSITY OF DUNDEE', 'UNIVERSITY OF ABERDEEN', 'UNIVERSITY OF NEWCASTLE', and 'UNIVERSITY OF Southampton'.

Figure A15.1 Page created in LifeGuide to demonstrate the creation of user accounts



The screenshot shows a web page confirming the creation of a user account. It has the same header and footer as Figure A15.1. The main heading is 'Better understanding of clinical practice: The management of URTIs'. In the center of the page, a message box states 'User Account Successfully Created'.

Figure A15.2 Page created in LifeGuide to confirm creation of user account

Appendix 16: LogicBlocks Evaluation Consort Diagram

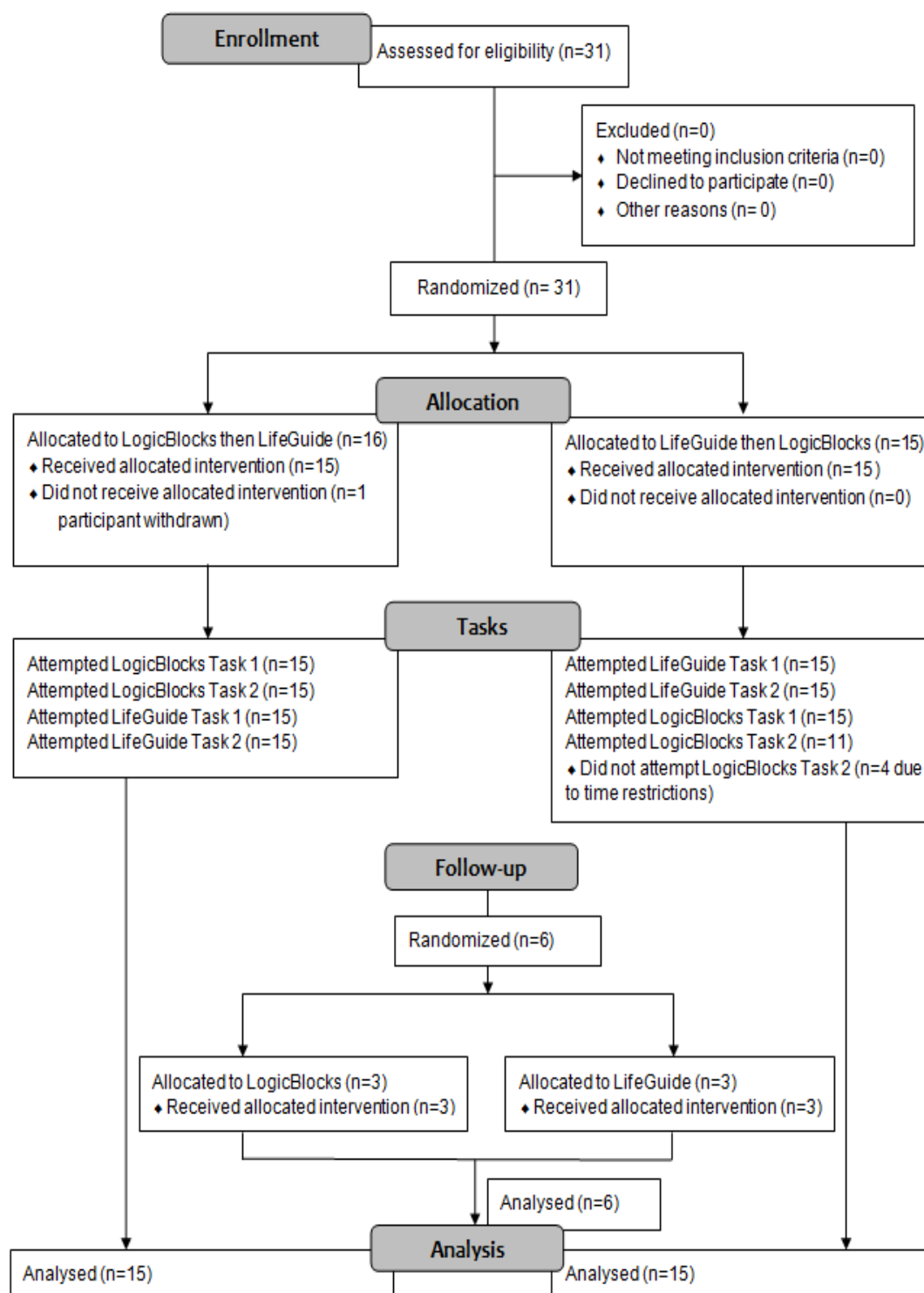


Figure A16.1 LogicBlocks Evaluation Consort Diagram